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Whither the Gas Industry?

THE "independent non-party group" concerning itself with "Political and Economic Planning" under the suggestively abbreviated title P E P, has added to its publications a "Report on the Gas Industry in Great Britain"*. This report has been produced by the Gas Group of P E P and will be followed, we are told, by a more comprehensive P E P report on fuel policy in Great Britain, for the purposes of which the findings of the coal, gas and electricity groups will be re-examined. The work has been well done and presents a picture of the gas industry as it exists to-day of a kind that, for interesting and revealing detail, has no rival. The development of the industry through various phases is also indicated with clarity, which is very desirable for a full understanding of the present situation and future possibilities.

For a long period after Murdoch and Winsor came forward a century ago with their processes for making coal-gas and using its luminous flame for lighting, improving technique simply served that purpose, important but limited, and under conditions of virtual monopoly. The introduction of the Bunsen burner and the Welsbach mantle, and the development of electrical supply, then played their part in gradually broadening the basis of the gas industry as a purveyor of heat as well as light, and in creating its competitive aspect. This has brought about the condition of to-day, in which the gas industry is no longer one for the heating of coal in retorts for making lighting-gas, but one for the systematic treatment of coal by carbonization and gasification in such a manner as to secure thereby products of maximum thermal, chemical and monetary values. The realization of these values has also demanded agencies for their proper utilization and, brought into the scope of the industry, schemes for the distribution of gas (the primary product) and the provision of efficient appliances for its combustion, as well as a new-found solicitude for the yields, quality and fate of coke, tar, and such chemical products as benzole, with its practically unlimited market as a liquid fuel.

With this increasing complication there has arisen the paramount necessity for scientific and efficient management, and for wise and far-seeing administration, if the industry is to deal adequately with the problems it has to face. There are such matters to settle as the degree of linking-up in production and management which may with advantage be effected, partly with a view to better supply and partly so as to bring first-class men into more effective use than is possible with the very numerous scattered works now in being and working independently. It may be pointed out that the small gas-works is not at all necessarily an uneconomical unit if well designed, constructed and run. Similarly, the best method of utilizing the spare gas from coke-oven plants well repays careful study. The possibilities in that direction have been demonstrated already in such districts as Sheffield, where the cheap supply obtainable by the gas company from neighbouring coke-oven plants has been largely responsible for the wide and extending use of coal-gas in metallurgical and other industrial furnaces.

Such utilization of coke-oven gas seems an obvious and desirable economy; but it raises questions which require careful consideration when one remembers, for example, that the coke oven

* Report on the Gas Industry in Great Britain: a Survey of the Current Trends and Problems of the Industry, with Proposals for its Future Development. Pp. vii + 213. (London: P E P, 1939.) 10s. 6d. net.

cannot with advantage continue to make unwanted metallurgical coke in order that the gas supply may be maintained. There is, again, the vexed question of tariffs in the gas industry, the allotment of charges on a rational basis to small and large consumers, where the gas industry has inherited statutory limitations imposed in the old days, which tell against it in competition with the newer electrical undertakings, the successful working of which is indeed largely conditioned by their greater freedom in this respect.

The discussion of these matters, even in brief, is not possible here; but they are gone into thoroughly in the P E P report, which is, in effect, a call to the industry to organize itself in a manner befitting its responsibilities and opportunities. The acknowledgment is rightly made of much that has already been done. It has to be admitted that contact has already been made with the universities (particularly Leeds), and some recruiting of young men, although not nearly enough, has been so effected with great advantage to the industry. Co-operation with the Board of Education has meant a considerable extension of such training as can be given by evening teaching in technical schools to the coming non-commissioned ranks, both for gas-manufacture and for supply.

Discussion and reports on technical and other matters are very full and frequent, partly because the various gas companies and municipal gas departments are not in direct competition with one another and can pool information more freely on that account. This is more particularly the province of the central Institution of Gas Engineers (and the branch associations), which in the past have rather tended to regard gas-engineering and gas-manufacture as the same thing, but are, slowly it is true, broadening their views and basis of membership so as to recognize the essential unity of the whole gas-engineering profession. The Society of British Gas Industries has served as a meeting-ground for the many industries concerned with the manufacture of gas plants and appliances for both domestic and industrial use; the British Commercial Gas Association has made itself responsible for publicity work, while the National Gas Council and, more recently, the Gas Federation, have effected co-ordination on matters of common interest, particularly on the financial, legal and political sides. Co-operative research work has been so far mainly the concern of the Institution of Gas Engineers through its Executive Research Committee and the Joint Research Committee of the Institution and the University of Leeds—a pioneering effort which has met with much success over a long term of years. There has, however, been also instituted a considerable research organization in the larger gas companies (particularly in London), contracting firms and appliance manufacturers.

The report is appreciative up to a point of all that the gas industry has done in organizing itself, but calls for a greater effort, and particularly a form of organization which shall include a new central authority within the industry for the co-ordination of its many activities. It would aim at giving full opportunities for the personnel of the industry to exercise its talents for the more general good and for the recruiting and training of first-class men. It would seek to effect an improvement, which is indeed needed in most of the industries of Great Britain, by not only securing an adequate supply of research workers, but also ensuring that the results of their work are understood and utilized by the executive management. It would aid schemes of development and amalgamation which it approved, and would claim a right to prohibit what it believed to be ill-advised.

Such extensive powers would plainly only be given after full consideration of their implications, and under such conditions as would not allow vested interests or bureaucratic self-confidence to impede travel along new paths. The long view is essential in such matters, and the future possibilities in the treatment of coal by the gas and cognate industries were perhaps never so alluring as at the present time. The use of high temperatures and pressures in combination for the gasification of coal is bringing into prominence new reactions for the controlled transformation of 'fixed carbon' into methane and other hydrocarbons, and the various technical potentialities of the gasification process, chemical and thermal, are awaiting more complete investigation. Moreover, perhaps the most striking feature of recent progress in the technical world has been the new chemical engineering which is emerging from a vastly increased knowledge of materials of construction, particularly in the metallurgical field, and this is going to facilitate enormously not only the laboratory investigation of determining conditions but also the translation of the results into large-scale processes. The gas industry has splendid opportunities, but only a well-founded and well-manned vessel can hope to sail these uncharted seas.

What We Know About Flow

Second Report on Viscosity and Plasticity

Prepared by the Committee for the Study of Viscosity of the Academy of Sciences at Amsterdam. (Verhandelingen der Koninklijke Nederlandsche Akademie van Wetenschappen, Afdeeling Natuurkunde, Eerste Sectie, Deel 16, No. 4.) Pp. viii + 287 + 2 plates. (Amsterdam : N. V. Noord-Hollandsche Uitgeversmaatschappij, 1938.) n.p.

THE subject of viscosity and plasticity is one of peculiar difficulty. The two states of matter of which we have a moderately satisfactory knowledge are the gaseous and the perfect solid. The flow of a gas is easily understood, but it is tolerably clear that the mechanism of gaseous flow has little bearing on that of liquid viscosity, since none of the basic assumptions is valid for the liquid state. The perfect crystal is incapable of plastic deformation, at any rate under forces anything like as small as those which produce deformation in real solids. We know extremely little about the liquid state, and there is practically no direct evidence for the internal flaws which we are forced to postulate in order to account for the softness of, in particular, metals, and even the conception of these flaws which the theories offer lacks definiteness.

The problem of flow is, however, fundamental for any understanding of the structure of real solids and liquids, and is, further, of the greatest importance for the industrialist who is concerned with metals, glasses, emulsions such as asphalt or clay, or plastic polymers, to mention only a few materials. The literature is so extensive, and the work has been carried out from so many different points of view, that one of the great needs of workers in this field is a reliable survey of the present position, and our Dutch colleagues have undertaken the task of supplying this need. The first volume of the "Report on Viscosity and Plasticity" prepared by a Committee of the Academy of Sciences at Amsterdam appeared in 1935, and received notice in NATURE (Nov. 2, 1935, p. 697). The second volume is now before us. In the interim, Dr. Houwink, who contributes a chapter on "The Yield Value" to this latter volume, has written a valuable book on "Elasticity and Plasticity" (see NATURE, May 7, 1938, p. 810) which in many ways supplements the "Reports".

The viscosity of simple liquids is the main subject of the first two chapters of this second "Report", due respectively to Dr. J. M. Burgers, who has played so prominent a part in the work of the Committee, of which he is the secretary, and to Prof. F. M. Jaeger. Certain generalities are first discussed, such as the statistical view of liquids with which the names of Prins and Bernal are connected, and the Prandtl model ; interesting as these are, it cannot be said that they have yet come into any very close contact with experiment. A survey is then given of various theories of liquid viscosity that have been put forward, starting with that of van der Waals junior. Some of these are based on the assumption that the viscosity is primarily a function of the specific volume, a view which offers grave difficulties, since Bridgman's work on viscosity at high pressures has shown clearly that widely different viscosities can attach to the same volume ; for example, for mercury, with which molecular distortions or associations cannot be invoked, the viscosity at equal volume is 0·0140 at 75° as against 0·0152 at 30°. The data on carbon dioxide, summarized in Fig. 11 of this "Report", are equally unambiguous on this point. Michels and Gibson found that, with high-pressure nitrogen at constant volume, the viscosity always increased with temperature. The obstacles in the way of the assumption might have been more strongly emphasized.

Generally speaking, the treatment of the various points of view is clear and critical, and the present writer has been gratified to find that difficulties which he has himself experienced have been felt by the author, with regard, for example, to the interesting calculations applied by Herzog and Kudar, where the exposition of the basic principles "is not such as to give a clear picture of what is actually intended", and, again, with regard to the obscurities of Lederer's theory. In general, there is a tendency on the part of many theorists to lose sight of the experimental facts, and, especially, of the need of showing how the absolute magnitude of the viscosity can be predicted. The theory of Eyring and Ewell is not reviewed at all, which is to be regretted, since a critical analysis of its assumptions and achievements would have been interesting. The account includes a welcome review of the extraordinary properties of the so-called 'liquid crystals' or liquids possessing mesomorphic states, and also deals with mixtures and solutions. Considering how little is known of simple liquids, it is not surprising that this part of the subject is not in a very satisfactory state.

A very valuable section, by Dr. J. M. Burgers, is devoted to the influence of suspended particles

on the viscosity of a liquid, a subject which is of topical interest in view of the importance attached to the experiments of Staudinger and his school. Here, as in so many fields, the pioneer paper is due to Einstein, who worked out the influence of spherical particles, and a further stage is represented by G. B. Jeffery's work on the behaviour of ellipsoidal particles in a viscous liquid. The problem is a particularly complicated one, in view of the conflict between the Brownian motion and the hydrodynamic forces in orienting elongated particles, a point on which experimental evidence is furnished by the double refraction of the flowing liquid.

Further difficulties are furnished by the possible deformation of long molecules, such as those of the polystyrenes, and the influence of the particles on one another. Dr. J. M. Burgers shows his usual skill in exposing, in a clear and critical manner, the essence of the large body of mathematical work which has been done on the problem, and in correlating it with experiment. His account is not overburdened with detail, but at the same time it is far from being a mere list of results. It supplies a clear and balanced picture, such as only one thoroughly conversant with the difficulties could give, of the present state of research on the subject. The general impression that it leaves is that, while much has been done, the conception of uniform, isolated rigid ellipsoids of revolution, immersed in a viscous fluid, is not altogether adequate to describe the behaviour of, for example, polystyrenes in solution.

The remainder of the "Report" is devoted to the discussion of 'yield value', to which reference has already been made, and to chapters on plastometers by Dr. C. J. van Nieuwenburg and on technical viscometers by Dr. R. N. J. Saal. The chapter on yield value contains an extension by Dr. J. M. Burgers of the treatment of the plastic flow of metal single crystals which he put forward in the first "Report". This development of the Becker-Orowan theory is extremely interesting and leads to expressions giving the dependence of the yield value on temperature and rate of deformation; unfortunately, there is the usual difficulty in throwing them into a form capable of critical experimental confirmation and in finding relevant experimental data. The attempt is, however, stimulating and suggestive. The introductory remarks of Dr. van Nieuwenburg should be read by all who attempt to design plastometers, since they present clearly the weaknesses that attach to most of the attempts to measure plasticity, a quantity which we cannot yet satisfactorily define. This lack of certainty as to what is really being measured finds its expression in the somewhat capricious design of the instruments.

A very valuable feature of this "Report" is its critical, but not carping, point of view. The authors have maintained their strong individuality, but they have not abused their position as reporters to push unduly any particular point of view. They have clearly pointed out the great gaps in our knowledge, but have not been too severe on those who have attempted to fill them, even if their efforts have been inadequate. The general impression left by the "Report" is how little we know for certain about the fundamental feature of flow phenomena. One of the best ways of emphasizing our needs, and of stimulating workers to supply them, is a report like this.

E. N. DA C. A.

Origins of Hindu Customs

Hindu Customs and their Origins
By Stanley Rice. Pp. 220. (London: George Allen and Unwin, Ltd., 1937.) 7*s*. 6*d*. net.

MR. STANLEY RICE, both as a member of the Indian Civil Service stationed in Madras, and after his retirement, as a member of the State Council of Baroda, has been in intimate relation with the problems of caste, which is the principal, though not the only, topic of this volume. Nowhere is the caste system so rigid as in Madras; while in Baroda he was an eye-witness of the difficulties which confronted the attempts to alleviate its more seriously obstructive characteristics, to which the Maharaja refers here in his foreword. It is not surprising, therefore, that although the author's interest in caste in this volume is that of the anthropologist and the student of origins, it is inevitable that he should from time to time take a side glance at its place in the present and future social and political situation in India.

Of the various theories which have been put forward from time to time to account for the existence of caste in India, Mr. Rice counts none as acceptable. The view that it arose out of the Aryan conquest involves, he shows, a number of inconsistencies and leaves much unexplained—not least, perhaps, that the caste system is more rigid in the south than in the north, where it is natural

to expect that an Aryan system would manifest itself most strongly. At the same time, he holds, it is no less difficult to accept occupation as the source of caste. This cause is not adequate to the effect, nor is the effect such as would naturally follow from such a cause.

The theory which Mr. Rice himself advocates is not entirely new; but it has not previously been worked out in detail. Shortly, it is that the system is indigenous to India, and was of aboriginal origin. It grew out of aboriginal elements assimilated by the conquering Dravidians, and by them was transmitted to the Aryans at some time considerably later than the Aryan invasion. The central features of caste, he points out, are the regulation of marriage and the fear of pollution by taking food or drink from, or by consorting with, a member of another forbidden or inferior caste. These two elements he traces to primitive taboos connected with on one hand totemism, and on the other with the conception of uncleanness or pollution. Such an aboriginal origin alone, he maintains, would explain the existence of outcastes or untouchables. As Hinduized aboriginals, on the theory of caste as originating from an Aryan conquest, they would automatically enter the ranks of the inferior castes and would not require a special category.

The solution which Mr. Rice offers is perhaps the best that so far has been suggested. At the same time it is not free from objection. The argument for totemism is by no means so strong as is claimed, and the association of animal forms with members of the Hindu pantheon is susceptible of explanation as a mode of Hindu thought which is not necessarily totemic. Further, is it true to say that in the matter of caste India is unique? Is it possible to set aside, as does Mr. Rice, the contention that it was characteristic of the group of Nordic peoples, of which the Arya were members? The obvious discrimination between caste and class distinction, to which he refers, rests on a comparison with modern conditions; and while they are perhaps stronger than he admits, historically they grew out of something far more rigid. Among the early Teutonic peoples breach of the marriage regulation was sometimes punishable by death. It would seem, therefore, as if the Aryan conquerors may have contributed more than a little to the system as a regulation of marriage, even though reference to it may be much later than their first appearance in India.

The influence of aboriginal culture in religious belief is traced further in discussion of the origin of reverence for the cow; while in the essay on the Brahman in Indian society, he glances incidentally, but with illuminating understanding, at the character, influence, and aims of this class in relation to the political situation.

Chapters dealing with Mahratta customs and the esoteric meaning of Hinduism complete a series of studies which is not only of interest to the anthropologist and student of Hindu culture, but also brings home to the lay reader the inner meaning of the day-to-day problems with which the administration and the statesman have been, and still are, confronted in dealing with the assemblage of races and beliefs which make up "India".

Farmland Grass

Grassland Management for the Practical Farmer By W. R. Peel. Pp. xv+191+8 plates. (London: Macmillan and Co., Ltd., 1938.) 7*s*. 6*d*. net.

THIS book deals with the subject and with the results of scientific investigations in a very practical way from start to finish, and it contains nothing which a farmer can fail to understand.

The author introduces his subject well by describing the general factors which determine the productivity of grasses, such as leaf to stem ratio and palatability. The differences in habit between indigenous and commercial strains are pointed out and the importance of the indigenous strains is stressed.

The characteristic habits of those grasses and clovers most commonly met with are well described, but, very wisely in a practical book on management, no morphology has been introduced. The factors to which certain grasses owe their importance agriculturally, such as palatability, early growth and winter greenness, are clearly set out, for the encouragement of desirable species to the exclusion of the less productive species is the underlying principle of good management.

The renown of the Romney Marsh pastures and the Leicestershire fattening pastures is familiar to all farmers; but few can have any clear idea how these famous pastures became established or why their productivity has persisted. The author shows how these and other well-known types of pastures, both good and bad, have been produced by the type of farming practised, and by management. He also shows how alterations in the type of

pasture are speedily brought about by a change from the traditional method of farming. The lesson to be learnt is that all pasture consists of associations of different species of grasses and clovers, and that any particular association is the result of a particular system of farming and management.

There follows, quite logically, a description of the various methods by which grassland can be improved, from the ploughing up and reseeding of the poorer types, to the harrowing and manuring of the types which have deteriorated least. Full practical details of the various methods of improvement are given, and the management of young grass in its early years receives the attention it merits. The various methods of conserving the extra grass at flush periods are described, and some valuable notes on silage-making and on the nutritive values of the conserved products are given in the appendixes.

Once the grassland is back to good productivity, careful management is required to maintain this productivity. The principles of good management are clearly set out, the need for controlled grazing and the periodic rest, the provision of the early bite and winter keep, and the manuring for pasture and hay are all fully described, as are the many other practical details of grassland management.

The last chapter deals effectively with the use of temporary pastures, and gives full details for sowing land down to grass, and of seeds mixtures. However, there is no bewildering list of seeds mixtures to confuse the farmer; but a few typical mixtures for various purposes are given. There are also useful notes on the most suitable arable crops to grow on freshly ploughed grass.

Farmers and others who have read this book will cease to look upon grass as such, but will see it as an association of many different species and strains of plants which require careful management to ensure full productivity; but which if left alone or not managed to maintain an association of the most productive species, will rapidly degenerate into an unproductive piece of land inhabited by a few species of grasses which have little or no feeding value.

The Life-Work of a Palæontologist

Published Papers and Addresses of John Campbell Merriam

Vol. 1. Pp. viii + 666. Vol. 2. Pp. vi + 667–1288. Vol. 3. Pp. viii + 1289–1944. Vol. 4. Pp. viii + 1945–2672. (Publication No. 500.) (Washington, D.C.: Carnegie Institution, 1938.)

BEFORE Dr. John C. Merriam became president of the Carnegie Institution, Washington, in 1920, he was for many years professor of palæontology and historical geology in the University of California at Berkeley. During that period he devoted special attention to the fossil vertebrates occurring in the coastal region of the western United States, and made many notable discoveries, which he described chiefly in the publications of the University and of the California Academy of Sciences. His scattered papers have now been collected and reprinted, with some addresses and more popular writings, in four handsome volumes, which are issued by the Carnegie Institution. They are admirably edited, with references to the source and original pagination of each paper; and when they are reduced from the quarto form many of the plates are subdivided to maintain the size of the figures. The reprints are arranged under several subject headings, and a bibliographical list in chronological order is appended to the fourth volume just before the index.

Dr. Merriam studied at Munich under Prof. K. A. von Zittel, and the first reprinted paper is his inaugural dissertation on some Pythonomorph reptiles from the Chalk of Kansas published in 1894. Then follow several papers on remains of new fossil reptiles which he collected from the Triassic formations of California and Nevada. His important discovery of the marine Rhynchocephalians which he named Thalattosauria is described and discussed in a memoir which was published in 1905. His valuable contributions to our knowledge of the Triassic Ichthyosauria form the subject of a still larger memoir which appeared in 1908.

Most of Dr. Merriam's papers are on fossil mammals, which were collected with special care to determine their relative ages. He began by examining the John Day region of Oregon, where he found mammalian remains of all periods from the Oligocene onwards. He then studied other western coast areas, and finally co-operated with the Los Angeles Museum in collecting and describing the skeletons of Pleistocene mammals found embedded in the asphalt lake of Rancho La Brea, which now forms a public park in the outskirts of Los Angeles. Rancho La Brea has yielded the most remarkable series of Pleistocene carnivores and birds of prey hitherto discovered. They were attracted to the spot by easy prey—peccaries,

horses, camels, elephants, ground sloths, and other animals which were accidentally trapped in the asphalt. Unfortunately, the detailed description of the collection is little more than begun.

Other papers discuss the discoveries of fossil man in association with extinct mammals in North America, and Dr. Merriam summarizes the results in an address which was delivered to the International Geological Congress at Washington in 1933. There seems to be no doubt that typically modern man lived in North America with some of the large mammals which became extinct before historic times.

The technical papers are followed by reprints of some popular articles on the same subjects; and the final volume is devoted chiefly to miscellaneous addresses and to papers on the educational use of the national parks. Dr. Merriam has done great service in providing guides and exhibits to help the public to appreciate the scientific interest of the vast open spaces which the United States Government has preserved for their enjoyment. His activities have indeed been numerous and varied, and the volumes before us form an imposing record of the life-work of a leading man of science.

A. S. W.

Popular Astronomy

(1) **Everyman's Astronomy**

By Mary Proctor. Pp. viii+246+23 plates. (London: The Scientific Book Club, 1939.) 2*s*. 6*d*.

(2) **Starcraft**

By William H. Barton, Jr., and Joseph Maron Joseph. Pp. vii+228. (New York and London: McGraw-Hill Book Co., Inc., 1938.) 10*s*. 6*d*.

(1) THE title of Miss Proctor's book is rather misleading, as it suggests a general elementary treatise. Actually, it is a collection of seventeen disconnected essays on astronomical subjects, written in a popular style. In its general scope it is somewhat reminiscent of the many similar volumes of essays published, sixty or seventy years ago, by the author's distinguished father, the late R. A. Proctor.

There is some internal evidence to suggest that the various chapters were written at different times. This has resulted in some repetitions and contradictions, and the attempt to bring the details up to date has not always been very successful. Perhaps the most interesting part of the book is to be found in the last seven essays, all of which deal with the subject of meteoric astronomy. Here the author has collected a considerable number of facts and numerical data relating to the more famous falls of meteorites, and these notes may be found useful for reference by other popular writers and lecturers.

The chief objection to the book is that it has throughout such a strong nineteenth-century flavour. The author appears only partly to have digested the results of modern research, and often quotes the necessarily tentative ideas of out-of-date authorities on matters which have long since ceased to be subjects for mere speculation.

There is also a tendency to dwell at great length on trivial points, while more important matters are either passed over or put in a way that can only mislead or mystify the reader. A few misprints occur in the book, but they are mostly too obviously such to be of serious consequence. There are some fine illustrations, though one is wrongly described in its legend.

(2) Messrs. Barton and Joseph have written their book for American schoolchildren. It is, in a sense, a field-book of elementary practical astronomy. The principal constellations are taken separately. A diagram of each is given, with instructions for finding it at various seasons of the year; and some short notes on the chief objects contained in it are added. There are also photographs of some of these objects, obtained with the large American telescopes.

Simple instructions are given for the making of a sundial and other astronomical instruments, including a reflecting telescope. With regard to the latter, we are inclined to think that any young person capable of following successfully the very abbreviated directions supplied would scarcely be satisfied with so scrappy a treatment of the subject.

There are some inaccuracies of statement in the book; for example, it is alleged that the companion of Polaris is visible in a field-glass, and that Saturn's rings are invisible to the naked eye because of their "faintness". The derivation of geocentric is given as "*geus*, the earth, and *centric*, the centre", while heliocentric is said to be derived from "*helio*, the sun, and *centric*, to circle about"!

The tone of the book is rather condescending, and the authors' attempts to be colloquial are often quite pathetic. Of course, American children may prefer "squinting" through a telescope to merely "looking" through it, like other people. All we can say is that those we have met have not seemed "that dumb".

W. H. STEAVENSON.

An Approach to a Philosophy of Education

By Dr. Theodore H. Eaton. Pp. ix+273. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1938.) 12*s*. 6*d*. net.

THIS book is in two parts. Part 1 (longer and more important) attempts the establishment of systems of values from the points of view of the biologist, the psychologist, and the student of social sciences. Part 2 deals with the application of those systems to education.

The book is a good example of that essentially American stream of pragmatic thought of which Dewey and Thorndike are representatives. Like them, the author eschews metaphysics and attempts to found a system of values out of the stuff of common experience; and like them he draws inspiration from the ever-changing phenomena of American society in the twentieth century.

Dr. Eaton finds the highest biological values in parenthood and self-preservation; the highest psychological values in the achievement of integrated personality; and the highest social values in a critical attitude of mind based on standards of general human welfare. Difficulties at some points seem too easily brushed aside. Summary treatment, for example, is accorded to such questions as the meaning of 'biologically fit', and the nature of those 'satisfactions' which are the basis of personality. Freedom is scarcely discussed at all, and too little is said in explanation of the power which ideals involving self-sacrifice have held. But the title of the book does not allow us to demand full treatment of all these.

The Mâléra of the Rajmahal Hills

By Sasanka Sekher Sarkar. Pp. xiv+135+11 plates. (Calcutta: The Book Co., Ltd., 1938.) 4 rupees; 6*s*.

THE author of this monograph, a recruit to anthropological research, to whom Sarat Chandra Roy extends a cordial welcome in a commendatory preface, has now spent some years in the investigation of the Mâléra of the Rajmahal Hills, and has already contributed a number of papers on specific points to scientific literature. In this work, which is of a more generally descriptive character, he is especially interested in the problem of their relation to the Oraons. He is unable to accept the view that they are a branch of the Oraons, a relic from the time of the migration of that people, presumably as a result of Moslem pressure. In support of his contention he points, *inter alia*, to the absence of totemism and exogamic clans among the Mâléra; while he stresses the fact that as a hill people, they never have occupied the plains, nor could they be persuaded by the Government to do so.

Only two accounts of this interesting people have appeared in print previously—some thirty years ago. A point of interest in the present account is the change which has taken, and is still taking place in their culture. Dormitories, for example, for bachelors and spinsters are now decaying institutions, while the ancient custom of interment, under Hindu influence, has given place to cremation.

A Textbook of Inorganic Chemistry for Colleges

By Prof. James F. Norris and Prof. Ralph C. Young. (International Chemical Series.) Second edition. Pp. x+803. (New York and London: McGraw-Hill Book Co., Inc., 1938.) 21*s*.

IN the preparation of the second edition of this book, Prof. Norris has been assisted by a co-author whose interests lie in the field of inorganic chemistry. A special feature of the book is the careful development of the fundamental ideas of atomic structure, isotopes, electronic valency, radioactivity, modern dissociation theory, etc., in such a way that they fit naturally into the course, and so much is presented at each step as can readily be understood by the student. The modern theory of acids and bases is used.

The pedagogic aspect of the subject has been kept constantly in mind, and for this reason the book will be of special interest to teachers. A useful feature is the numbered bibliography at the end, providing a wide range of suitable material from which both students and teachers can extend their knowledge of particular topics in which they are specially interested.

L'Antenne Rayonnante

Par Pierre Baudoux. (Institut Belge de Recherches Radioscientifiques, vol. 7.) Pp. 235. (Paris: Gauthier-Villars et Cie., 1938.) 40 francs.

THIS publication is a monograph describing a mathematical analysis of the current distribution in antennæ of various forms and of the resulting radiation therefrom. The classical theory of the problem is outlined, and the author then obtains solutions and an analysis of the appropriate coefficients to a closer degree of approximation than hitherto. After considering the vertical antenna of uniform cross-section, he deals with the spindle (or cigar-shape) and pyramidal forms of antennæ that are now in such common use at radio transmitting stations. The dipole antenna is also dealt with. The final chapter describes experiments carried out with model antennæ of various shapes of about 1·5 metres in height using oscillations of wave-length 2–5 metres. The current distribution in these models was measured and the resulting radiation deduced for comparison with the theoretical analysis. R. L. S. R.

Fortschritte der Biochemie

Teil 3 (1931–1938). Von Prof. Dr. Felix Haurowitz. (Wissenschaftliche Forschungsberichte: Naturwissenschaftliche Reihe, herausgegeben von Dr. Raphael Ed. Liesegang, Band 49.) Pp. xi+167. (Dresden und Leipzig: Theodor Steinkopff, 1938.) 9 gold marks.

THIS is the third volume of a series in which Prof. Haurowitz has presented reviews of the progress of biochemical research over a period of years. The present work covers the period 1931 to the beginning of 1938. It is comprehensive, concise and accurate, but it is unlikely to appeal to British or American men of science, who are accustomed to rely on reviews which appear annually and usually treat subjects in greater detail. J. C. D.

The Last Thousand Feet on Everest

Physiological Aspects

By Prof. Yandell Henderson, Yale University

A MOUNTAINEER at rest on the North Col of Mount Everest (bar. 335 mm.) probably consumes nearly the same amount of oxygen as at sea-level. This amount, 250–350 c.c. S.T.P. per minute, is required for the maintenance metabolism of muscle tonus, the resting heat production and the work of breathing and the heart beat. If a mountaineer ever rests on the summit of Everest (bar. 240 mm.), even there he will probably consume nearly the same amount. On any less, anywhere, he would die.

When he climbs, a man consumes far more oxygen; but at every altitude the amount is limited by the barometer. He cannot do more work in climbing, nor climb faster, than the oxygen that he can absorb from the air will permit. No amount of muscular strength can escape this limitation. The advantage of the athlete over the ordinary man, and the superiority of the acclimatized mountaineer over the unacclimatized, consist less in their strength than in their ability to obtain larger amounts of oxygen.

During steady vigorous exertion for an hour or more at sea-level, or up to 5,000 feet, a man may absorb and consume ten or twelve times the resting amount of oxygen, with a corresponding expenditure of energy. For shorter periods the rate of consumption may be much more, but not for long. As he ascends and the air grows thinner, the amount of oxygen that he can obtain, even by the greatest possible volume of breathing, decreases; and his decreased capacity for work results in a directly proportional decrease in the number of feet, or metres, that he can climb upward in each hour. Up to the greatest altitude and lowest barometer for which a man's oxygen consumption and capacity for work in climbing have been reported—by Christensen in the Andes—the ratios of oxygen to work are nearly uniform with those at sea level.

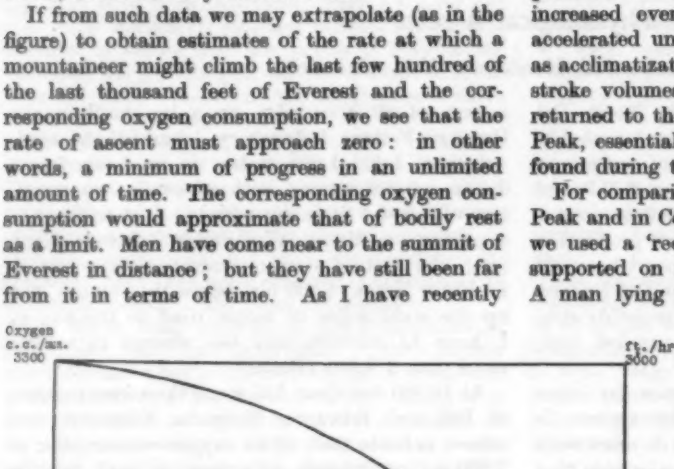
From measurements on Marathon runners by Benedict and Cathcart, and others, we know that a vigorous young man can consume 3,300 cubic centimetres of oxygen per minute for two hours or more. Such men do an amount of work equivalent to climbing 3,000 feet, or even a thousand metres, an hour; and men have done this, although the ordinary rate of climbing in the Alps and Rockies is only 1,200–1,800 feet an hour. As an extreme case Dr. D. B. Dill informs me of a man of 80 kilos who, on a treadmill in the Harvard Fatigue Laboratory, 'climbed' the equivalent of 1,400–1,500 metres in an hour, linear distance 5,000 metres, with an oxygen consumption of 4·0–4·4 litres per minute. Last summer in a contest on Mount Washington (altitude 6,288 feet), the best of sixteen contestants starting at Pinkham Notch, 4,800 feet below the summit, ran up the eight miles of motor road to the top in 1 hour 17 minutes, and the slowest in a little more than 2 hours (Foster).

At 10,000 feet (bar. 525 mm.) the measurements of Dill and Edwards, Margaria, Schneider and others, indicate that, on an oxygen consumption of 2,800 c.c. per minute, an amount of work may be performed equivalent to that of a man weighing 150 lb. and climbing about 2,500 feet an hour. At 14,000 feet on Pike's Peak, Schneider and I repeatedly ascended 1,000 feet in half an hour, and we were both well past the age of greatest vigour. The manager of the Summit House, whose weight was 156 lb., climbed from Manitou (altitude 6,600 feet) to the summit up the cog railroad, a rise of 7,500 feet in 8·9 miles, in two hours and thirty-one minutes. He probably climbed more rapidly at first than toward the end of the ascent. But very few men could make such a climb, at such a rate, at such an altitude. The oxygen consumption found by Christensen in the Andes at 17,500 feet (5,340 metres) was 1,800 c.c. per minute, and the work done on a bicycle ergometer was equivalent to that of a man of 70 kilos (154 lb.) climbing 600 metres an hour. The periods of exertion were less than an hour. But the natives, as Dr. Dill informs me, commonly climb from their homes at 17,500 feet up to the sulphur mine where they work at 18,800 feet in about an hour.

For greater altitudes there are no measurements of oxygen consumption on acclimatized, or partially acclimatized men. But the rates at which men can climb at the great altitudes of the upper slopes of Mount Everest and other peaks in the Himalaya are significant. There the rates of climbing decrease progressively as the altitude increases; and we may fairly infer that the amounts of oxygen that the men can obtain from the air decrease correspondingly. As they go higher and higher their rate of ascent becomes slower and slower, until at 27,000 feet Somervell

had to "take 8 or 10 respirations for each step, and stop to rest for a minute or two every 20 or 30 yards. At 28,000 feet Norton, in an hour's climb, ascended only about 80 feet."

If from such data we may extrapolate (as in the figure) to obtain estimates of the rate at which a mountaineer might climb the last few hundred of the last thousand feet of Everest and the corresponding oxygen consumption, we see that the rate of ascent must approach zero: in other words, a minimum of progress in an unlimited amount of time. The corresponding oxygen consumption would approximate that of bodily rest as a limit. Men have come near to the summit of Everest in distance; but they have still been far from it in terms of time. As I have recently pointed out elsewhere, inhalation of oxygen from an 'open circuit' inhalator, although helpful during rest, is of no value during climbing; for all the oxygen is blown away by the tremendous volume of breathing. Only by the use of a 'closed circuit' respirator, such as that used in mine rescue operations, can men obtain sufficient oxygen and climb sufficiently rapidly to ascend and descend the last one or two thousand feet of Everest within the period of a day.



APPROXIMATE AMOUNT OF OXYGEN THAT A MAN CAN OBTAIN AND UTILIZE DURING STEADY CLIMBING AT ALL ALTITUDES BETWEEN SEA-LEVEL AND THE SUMMIT OF MOUNT EVEREST, AND THE MAXIMUM RATES IN FEET PER HOUR AT WHICH HE CAN ASCEND.

THE HEART AT GREAT ALTITUDES

The mountaineer is generally inclined to consider his heart as the organ that limits his exertions. But the above considerations tend to indicate that such is not the case. During the Oxford-Yale expedition, which spent five weeks on the summit of Pike's Peak, altitude 14,100 feet, during the summer of 1911, we found both in ourselves and others that during mountain sickness the stroke volumes of the heart were diminished; arterial pressure was lowered; and the pulse rate was increased even during bodily rest, and greatly accelerated under even moderate exertion. But, as acclimatization developed, arterial pressure, the stroke volumes of the heart, and the pulse rates, returned to the same values as at the foot of the Peak, essentially as Christensen and Forbes have found during the recent expedition to the Andes.

For comparison of the stroke volume on Pike's Peak and in Colorado Springs (altitude 6,000 feet) we used a 'recoil board'—a light wooden plank supported on a number of soft rubber stoppers. A man lying upon it illustrates the Newtonian principle that "every action has an equal and opposite reaction"; for with each heart beat, as blood is propelled alternately headward and feetward, the man's body and the plank recoil in the opposite direction. This movement of about 0·1 mm. was magnified sixty times by a system of levers and recorded on a smoked drum. As the amplitudes of these curves and the arterial pressures were the same in acclimatized men at 14,100 feet as at 6,000 feet, the strokes of the heart must also have been of the same volume and force.

From these observations it appears that readjustment of the circulation plays no considerable part in acclimatization. During intense muscular exertion at sea-level, the volume of blood that the heart can pump is probably one of the factors that limit exertion. At great altitudes the limiting factor appears to be chiefly the volume of air that a man can respire, or rather the amount of oxygen that he can absorb from it. As he obtains less oxygen his muscles can do less work; and as his muscles contract less often the volume of the venous return to the heart, which limits the volume that the heart has to pump, is probably much less than during vigorous exertion at sea-level.

Above altitudes of 20,000 feet, according to Argyll Campbell, acclimatization becomes increasingly incomplete. As he has shown also, after a prolonged stay under a low pressure of oxygen, the heart suffers along with other organs and functions. But any ill-effects after mountaineering at great altitudes are assignable rather to prolonged slight asphyxia than to any strain from overwork.

Readjustments in Acclimatization

Acclimatization to any altitude above or below sea-level, or to sea-level, is wholly a response to the pressure of oxygen, and not to that of the barometer otherwise. It is an adjustment which enables the acclimatized man to obtain sufficient oxygen to live normally, or nearly normally, at altitudes at which, if wholly unacclimatized, he would become unconscious or even die. The readjustment is not in the heart or lungs, but consists chiefly in alterations in the composition of the blood. The red corpuscles are increased and —even more helpful—the bicarbonates ($BHCO_3$) of the plasma are decreased. Until the bicarbonates are decreased the mountaineer cannot breathe any very much larger volume of air without disturbing the relation of the carbonic acid (H_2CO_3) and bicarbonates, and thus the hydrogen ion concentration, of his blood.

The decrease of bicarbonates is not effected through any process of an acidotic type. It develops through an entirely different process in three stages: (1) The sensitivity or excitability of the respiratory centre (E_H) varies inversely with the pressure of oxygen (O_2), or, more precisely, with the ratio of the pressure of oxygen to the bicarbonates of the blood, that is, $E_H \propto (BHCO_3) : (O_2)$; and the initial increase in the volume of respiration is due to this increase of sensitivity. (2) The increase of pulmonary ventilation decreases the partial pressure of carbon dioxide in the air of the lungs, and the amount of carbonic acid in the arterial blood. The relation $(H_2CO_3) : (BHCO_3)$ and the pH of the blood are thereby temporarily disturbed; and (3) this disturbance in turn induces a compensatory decrease of bicarbonates which restores both the relations $(O_2) : (BHCO_3)$ and $(H_2CO_3) : (BHCO_3)$ to normal levels. On descent to a lower altitude these processes are reversed.

The decrease of the bicarbonates in the blood affords two advantages to the acclimatized man. It causes him to breathe a larger volume of air than at sea-level on the same production of carbon dioxide, and thereby raises the pressure of oxygen in his lungs and arterial blood. Less well recognized, but equally important, is the effect of the lowered bicarbonates upon the interchange of gases as the blood passes through the tissues. As the amount of carbon dioxide produced in the tissues is the same under the same exertion at all altitudes, any decrease of the bicarbonates allows the carbon dioxide to exert a much greater effect upon the ratio $(H_2CO_3) : (BHCO_3)$ and the hydrogen ion concentration than it would if the bicarbonates were at sea-level value. This increase of hydrogen ions promotes the unloading of oxygen from hæmoglobin.

Yet acclimatization to a great altitude also imposes a handicap. It has been supposed that men or horses—particularly in the Andes—that have come from a higher to a lower level shortly before a race should have an advantage. Exactly the opposite is, however, the case; for Edwards has recently reported that a man acclimatized to an altitude can there do less work on a bicycle ergometer than at sea-level, even if the oxygen in the air that he breathes is artificially increased to the sea-level amount (150 mm. partial pressure). The probable reason is that, owing to the lowering of the bicarbonates in the blood, the man must breathe a correspondingly increased volume of air in order to exhale the increased amount of carbon dioxide.

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Shape of Tobacco Mosaic Virus Particles in Solution

By Dr. J. R. Robinson

THE ease with which solutions of the tobacco mosaic virus protein show a strong double refraction of flow suggests that the particles present are extremely elongated. It was reported by Bawden and Pirie[1], who described the general properties of the virus. Bernal and Fankuchen[2] studied the virus by means of X-rays, and pointed out that the long tapering structures which have been called crystals are more strictly paracrystals. There is regularity of arrangement in the cross-section, but not in the direction of the long axis. The paracrystals are believed to consist of long, rigid rods, packed closely side by side, but without order, in the direction of their length. These rods

are supposed to exist free in solutions of the virus. By their orientation they give rise to the double refraction of flow.

It has now been shown clearly[3,4] that the double refraction of flow does in fact arise from the orientation of rigid rods, and not from the deformation of flexible particles. Kuhn[3] gives a method of determining, from measurements of double refraction of flow and of the angle of isocline, the amount of double refraction to be ascribed to any individual particle with its immediate fluid environment. Calculations such as Kuhn describes have been applied to the results of measurements upon virus solutions supplied by Dr. N. W. Pirie. They show that a tenfold increase in the double refraction of flow with increasing rate of shear is not accompanied by a corresponding increase in the birefringence of the individual particles.

From the fact that spontaneous birefringence first appears in the solutions at a concentration of 1·6 per cent, Bawden and Pirie suggest, on the assumption that this represents Staudinger's limiting concentration, an axial ratio of the order of 90. But they point out that the particles are highly charged, so that the interpretation of the critical concentration is complicated. Moreover, the observed critical concentration almost certainly does not correspond to Staudinger's limiting concentration. For this is calculated from an effective volume which requires that the particles be free to rotate in the solution about central axes perpendicular to their lengths, so that each may trace out a disk[6,7] (Staudinger, 1931, and 1932, p. 129), whereas spontaneous birefringence implies that the particles are not free to move (whether through mechanical interference or by reason of their charges). If they were free to move, they would attain random orientation, and the solution would become isotropic.

Attempts to determine precisely the shape of the virus particles have usually been based upon measurements of viscosity. Unfortunately, the theory of the viscosity of suspensions is in its present state insufficiently developed to permit of a completely satisfactory solution of the problem. Certain general principles have, however, emerged, and as these are passed over or violated in much of the published work, it may be worth while to review the situation.

Interpretation of the experimental results has generally been sought through the aid of an equation due to Kuhn[2], which may be stated in the form

$$\eta_{sp.} = 2{\cdot}5\varphi + \frac{\varphi f^2}{16}. \qquad (1)$$

Here $\eta_{sp.}$ is the specific viscosity, defined as $\eta_{rel.} - 1$, where $\eta_{rel.}$ is the relative viscosity. Since $\eta_{rel.}$ is the ratio of the viscosity, η^1, of a suspension or solution to that of the pure solvent, η_0, the definition may be formally stated as

$$\eta_{sp.} = \eta_{rel.} - 1 = \frac{\eta^1 - \eta_0}{\eta_0}. \qquad (2)$$

If the total volume of the particles is v, and that of the solvent is V, where v is very small compared with V, then φ is defined as $= v/V$. f is the axial ratio of any particle, the ratio of its length to its diameter.

From its derivation, equation (1) is applicable only to suspensions so dilute that there is no interaction between a given particle and any other particle, but only between the particles severally and the liquid immediately surrounding them.

It is also only applicable when Brownian agitation is overwhelming, so that there is random orientation. The extent to which this condition is not fulfilled in practice does not seem to be realized, though Lauffer[8], who used a high precision quartz viscometer, admits that the particles may be "somewhat" orientated. This condition is important because the orientation of the particles, which becomes more marked as higher rates of shear are applied, is accompanied by a decrease in the measured viscosity. This has been shown experimentally by simultaneous measurements of the viscosity and of the optical properties of a 0·02 per cent solution of the virus in a rotating cylinder viscometer. A beam of plane polarized sodium light was passed through the annulus of a Couette viscometer, parallel to the common axis of the cylinders. The angle of isocline, which gives the direction of orientation of the particles, was found by rotating the polarizer and the analyser together and crossed. The strength of the double refraction, which gives the intensity of the orientation, was determined by inserting a quarter-wave plate orthogonally to the polarizer, and rotating the analyser alone as in the method of compensation due to de Sénarmont. It was also found possible to develop a theoretical explanation which yields successful quantitative predictions of the variation of the viscosity with the rate of shear. This is further confirmed by the agreement of experiments and predictions upon the sign and magnitude of the temperature coefficient of relative viscosity.

Briefly, the orientation is the statistical aspect of precessional motions imposed upon the suspended particles by the velocity gradient in the flowing liquid. That direction of the particles for which the precessional motions have their minimum angular velocity is their most probable direction, and therefore the direction of orientation. Theory and experiment agree that as the velocity gradient increases, the direction of orientation approaches that of the streamlines (the angle of

isocline increases from 45° towards 90°); and the intensity of the orientation increases (the strength of the double refraction of flow increases). To maintain the precessional motions of the particles, work must be done continually. As the velocity gradient is increased, the theory shows that, on account of the increasing orientation, the amount of work so used becomes less compared with that required to maintain the flow of the solvent alone. Since the viscosity coefficient of a liquid is a measure of the rate at which energy is dissipated in its flow, this is reflected experimentally in a reduction in the measured viscosity. Dilute suspensions of the virus exhibit a distinct viscous anomaly.

Because of this anomaly and the extensive orientation which is its basis, measurements made at high rates of shear cannot be interpreted satisfactorily by means of Kuhn's equation. It has already been mentioned that Kuhn gives a method for determining the birefringence to be associated with each particle, and with it, of the maximum possible double refraction of flow which would correspond to a complete orientation of the particles. With the 0·02 per cent virus solution, one half of this value is reached at a velocity gradient of 5·6 cm. per sec. per cm. in the Couette apparatus. The rates of shear in capillary viscometers are generally hundreds or thousands of times greater than this, so that the assumption of random orientation is unjustified.

Yet most workers seem to have used capillary viscometers, and to have published no data from which the rate of shear might be computed. Lauffer states that his results were obtained with such an instrument. Frampton and Neurath[10] do not state how they obtained their results. That they are in good agreement with those of Lauffer suggests that they also used a capillary viscometer.

It is instructive to compare the results of Lauffer[11] with those obtained in the Couette instrument. Lauffer states that the specific viscosity of a 0·0296 per cent solution of the virus is 0·0165. The following figures were obtained with a 0·02 per cent solution in the Couette apparatus.

Mean rate of shear (sec.$^{-1}$) ...	0·36	0·72	1·44	2·16	2·88	3·60	4·32	5·04
Specific viscosity ...	0·291	0·279	0·260	0·243	0·230	0·219	0·205	0·199

Short extrapolation gives the value 0·30 for zero shear, and this is confirmed by the theory. If Kuhn's equation can be applied to any of these results, it is to that for zero shear, where alone the orientation is random. This would give $f = 176$, approximately, instead of Lauffer's value of 35.

The theoretical treatment, the general description of which has been given, replaces Kuhn's equation by the more complicated one,

$$\eta_{sp.} = \frac{\varphi f^3}{4}\left[1 - \frac{\Delta}{\Delta_m}(1 - 2\cos^2\Psi)\right], \qquad (3)$$

where Δ is the observed double refraction of flow at any rate of shear, Δ_m is the maximum value corresponding to complete orientation, Ψ is the observed angle of isocline at the given rate of shear, and the remaining symbols have the meanings already allotted to them.

This equation does not assume that the orientation is random, but takes account of its progressive increase as the rate of shear is raised, and so predicts the viscous anomaly. Applied to the experimental results obtained with the 0·02 per cent virus solution, it suggests that f is of the order of 87. (The actual figure is not stressed, for the virus preparation was not fresh. What is important is the anomaly, and the caution which it demands in interpreting measurements made with flow viscometers.)

It must be emphasized that this is not the axial ratio of the virus particle, but only that of the model particle, conceived as a rigid string of beads, which leads to a predicted viscosity equal to that observed for the virus. It does not seem to have been realized that precisely the same difficulty is inherent in Kuhn's equation.

It should also be noted that the equations (1) and (3) are extremely approximate in their derivation, so that they can only indicate the order of magnitude of f. More strict hydrodynamical treatment would have given a less rapid rise in specific viscosity than that proportional to f^3 which the approximate theories indicate.

Neurath and Saum[12] have recently approached the problem by comparing measurements of molecular weight by diffusion and in the ultracentrifuge. They suggest a shape factor which would correspond to a value of f between 52 and 56. It is impossible to assess this result in the absence of more details as to its derivation, but it is interesting to note that it falls between 87 and Lauffer's obviously too low figure of 35.

Whether or no it is justifiable to assume random orientation depends mainly upon the absolute size of the suspended particles. For the existing orientation represents a dynamic equilibrium between a hydrodynamic orientating tendency and the disorientating Brownian agitation. As the size of the particles increases, the former effect becomes more, the latter less, important. The diffusion coefficient for angular rotation, which measures the intensity of the Brownian agitation, is roughly inversely proportional to the cube of the length of the particle. The degree of orientation depends

upon the relation of this quantity to the value of the velocity gradient. In a recent theoretical paper, Peterlin shows that random orientation can only be asserted if the suspended particles are shorter than 10^{-6} cm. Lauffer[11] suggests that the length of the virus particle is of the order of 10^{-4} cm., which would exclude the assumption of random orientation involved in his use of Kuhn's equation. Since Kuhn's equation can only be applied when the particles are smaller than 10^{-6} cm., it is clear that its use in interpreting measurements of the viscosity of virus solutions should be discontinued.

Only measurements made in a cylinder apparatus, where simultaneous control and determination of the state of orientation are possible, can be expected to be significant when the particles are so large as to be considerably orientated at low rates of shear.

Quite apart from the high rate of shear which inevitably obtains in them, capillary viscometers are quite unsuited for the study of anomalous systems. In these systems the viscosity depends upon the rate of shear. In a capillary viscometer the rate of shear, and with it the viscosity of an anomalous liquid, varies across the lumen from a high value near the walls to zero on the axis of the flow tube. No precise significance can be attached to a measured 'viscosity'.

G. I. Taylor[13] reported that in his model experiments some time was required for the establishment in a steady state of the motions of precession of the particles. Peterlin[14] points out that even when the particles are so small as those of the virus, this process may require some seconds. All theoretical formulæ which are not concerned with a variation of viscosity with time must assume that this steady state is reached. In a cylinder apparatus, unlimited time may be allowed for its attainment. But in a capillary viscometer, a given element of volume of the liquid remains in the flow tube only for a fraction of a second, and time may not be allowed for the steady state to be established.

Since the variation of the velocity gradient across the lumen of the capillary is accompanied by a variation in the state of orientation, capillary methods are also unsuited for the measurement of double refraction of flow. The double refraction of flow of the suspension as a whole can only be referred to the birefringence of the individual particles if an independent measurement of the state of orientation is also possible. Comparisons between different systems are only valuable if they can be made in corresponding states of orientation. When a cylinder instrument is used, the angle of isocline may be measured as well as the double refraction, and provides the necessary control.

The methodological problem is summed up in the statement that the viscosity of a suspension is most emphatically not a simple physical property of that suspension, as it would be of a Newtonian liquid. The energy dissipated depends upon the type and upon the rate of flow; so the recorded viscosity depends upon the method of measurement, and especially upon the rate of shear which is employed. A statement of the 'viscosity' of an anomalous system which does not include reference to these controlling factors has little meaning.

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Lazzaro Spallanzani

Celebration at Pavia

ON April 11–15, the University of Pavia honoured the memory of one of its greatest sons, Lazzaro Spallanzani (1729–1799). The celebrations took the form of a special meeting of the Italian Society of Experimental Biologists, to which a number of representative foreign men of science were invited, with closely associated and contemporaneous meetings of the Italian Botanical and Geological Societies, as well as a congress of veterinarians.

On the morning of April 11, in the Great Hall of the University, with a Duke of the Royal House presiding, there assembled a most colourful company to listen to the oration given by Prof. Botazzi of Naples, and to receive the greetings and congratulations conveyed from scientific bodies and institutions in foreign countries by their official delegates. Thereafter the company passed along cool cloisters bedecked by fine statues and plaques to the Pavian worthies—Volta, Golgi, among

others—to the quadrangle where the shrouded marble figure of Spallanzani waited. The unveiling itself was a simple act, and then it seemed that relative merit had at last been recognized, for the fine new monument dominated its environment; then to lunch, given by the Mayor of Pavia in the splendid and attractive Almo Collegio Borromeo. Then, somewhat reluctantly, for the entertainment was rich and satisfying, on to the Aula Spallanzani in the Zoological Institute, formerly a palace and, so far as university department buildings go, still most palatial. If the place where work is done affects its quality, then no wonder great discoveries have been made in Pavia.

All through the afternoon, specialists in different fields of biology, each acknowledged in his turn the indebtedness of his particular branch of science to Spallanzani. It was an inspiring experience to stand and speak where he had stood and taught. His mantle seemed to brush one's shoulder. As speaker followed speaker, it seemed that the history of science in the eighteenth century was a record of Spallanzani's own work: 1754–60, a teacher of logic, metaphysics and Greek in the University of Reggio; 1760, lecturer in the Natural History Department of the University of Modena; 1769, invited to the chair of natural history in Pavia, a post which he adorned until his death. Whilst at Modena he had been active in experimentation designed to test the reality of spontaneous generation, and his contributions concerning the anatomy and physiology of the circulatory system were of such quality as to justify Haller's dedication to him of one of the volumes of his "Treatise of Physiology". With the greater opportunities that Pavia offered, his interests passed rapidly from problems of regeneration to the origin of springs, to the systematics of the Protozoa, to the functions of chlorophyll, to tissue respiration, to the role of the sperm in fertilization, to the chemical aspects of digestion, whilst at the same time work carried out on journeys along the Mediterranean coast earned for him the title of the founder of volcanology. He augmented the content of each and every subject that he touched, and many of his discoveries, being made before their quality could be assessed, had long to lie dormant until men's minds were later turned in their direction.

STATUE OF SPALLANZANI AT THE UNIVERSITY OF PAVIA

It was not surprising, therefore, to listen, during the afternoon and the following three days, to a series of papers dealing with the most diverse of subjects, every one of them nevertheless testifying to the fact that Spallanzani had made notable contributions to each and all. Abderhalden (Halle) on digestion; Federley (Helsingfors) on the chromosome and gene; Ruggles Gates (London) on the nature of genic differences; Camara (Lisbon) on the branched chromosome; von Muralt (Bern) on the relationship of Spallanzani and Albrecht von Haller; Pupilli (Bologna) on the physiology of the circulatory system; Crew (Edinburgh) on artifical insemination and its uses in the experimental study of the species problem; Timoféeff-Ressovsky (Berlin) on genetics and evolution; Jucci (Pavia) on physiological genetics; Montalenti (Bologna) on tissue respiration; Brunetti (Pavia) on animal electricity; Baltzer (Bern) on hybrid grafts and partial homology of nuclei from different species, were among those who contributed to the homage that was so gladly paid. Meanwhile the botanists, geologists and veterinarians were similarly occupied, so that the air of Pavia must have been heavily laden with well-merited eulogy of Spallanzani.

The veterinarians in their meetings dealt entirely with the techniques and possible uses of artificial insemination. It will be remembered that Spallanzani, being greatly impressed by the results of the artificial insemination of trout eggs by Waltheim, succeeded in 1779 in artificially inseminating a bitch. It is a great pity that at

this meeting there was no one from the U.S.S.R. Had there been, they could have been reminded that they, who have exploited this technique more than any other people, are greatly indebted to the Italian Spallanzani, and their hosts could have been given further reason for their rejoicings by the knowledge that Spallanzani's early sowings had produced so abundant a harvest.

The foreign delegates were housed in the Collegio Ghislieri and in the Almo Collegio Borromeo. 'Housed' is certainly the wrong word, for the hospitality they received was so warm and so friendly, and the accommodation itself so welcoming, that they who had come as strangers, left as friends.

During the days of the congress when for brief intervals the clamour of discussion died down, there were pleasant excursions to the Certosa di Pavia, a Carthusian monastery crowded with works of art; to the town of Pavia itself; and to the Spallanzani Museum at Reggio. In addition there were evening concerts, exquisite yet informal, such as could only be enjoyed in Italy, in the rooms of the Circolo del Littorio. The foreign delegates came away full of admiration and gratitude, entertaining the wish that all congresses, if not meeting in Italy where they do these things so well, should at least be constructed on the Italian model.

This celebration was notable also for the appearance of the first number of a new journal, *Scientica Genetica* (see NATURE of April 22, p. 676). This is a matter of some considerable interest for it truly marks a stage in the development of this science in Italy. A rapidly growing school exists and the stage of its development is indicated by the recognition of the need for the publication of a specialist scientific journal which will cater primarily for the geneticists of the Latin-speaking countries.

F. A. E. CREW.

Obituary Notices

Sir Frank Dyson, K.B.E., F.R.S.

IT is with much regret that we record the death at sea on May 25 of Sir Frank Dyson, Astronomer Royal from 1910 until 1933, whilst on the voyage home after a visit to Australia.

Frank Watson Dyson was born on January 8, 1868, and was educated at Bradford Grammar School and Trinity College, Cambridge. He was second wrangler in the Mathematical Tripos in 1889, and was placed in Class I, Division 2, in Part II of the Tripos in the following year. He was awarded a Smith's Prize and elected to a fellowship at Trinity College. In 1892 he was appointed to an Isaac Newton Studentship, being the second holder of the studentship, which had shortly before been endowed by Mr. Frank McClean for research in astronomy or physical optics.

In 1894 there occurred a vacancy in the post of chief assistant at the Royal Observatory, Greenwich, through the election of H. H. Turner to the Savilian professorship at Oxford, and Dyson was selected by the Astronomer Royal, W. H. M. Christie, to fill the vacancy. The choice proved to be a singularly happy one, and Dyson threw himself with characteristic energy and enthusiasm into the various branches of the work at Greenwich.

Dyson's first important work, undertaken in collaboration with W. G. Thackeray, one of the assistants, was a new edition of Groombridge's Circumpolar Catalogue. Stephen Groombridge, a retired West Indian merchant, had made at Blackheath between the years 1806 and 1819 some 27,000 observations of more than 4,000 circumpolar stars, using a 3½-inch aperture transit circle of 5 feet focal length. The observations had been well made, with careful attention to the instrumental adjustments, but the reductions were not in accordance with modern ideas of accuracy. A complete new reduction was made, starting from the original observing books. The Groombridge stars were re-observed at Greenwich, and from the comparison of the two series of observations, supplemented by such other observations as were available, the proper-motions of the stars were derived. These proper-motions were discussed for the derivation of the constant of precession and the solar motion. The work was completed in 1905 and provided a valuable addition to the available data on the proper-motions of the stars. The publication came at an opportune time. In the previous year Kapteyn had announced his important discovery of star-streaming from the analysis of the proper-motions of the bright stars observed by Bradley in the years 1750–62. The Groombridge proper-motions were used by A. S. Eddington, who succeeded Dyson as chief assistant at Greenwich on the appointment of Dyson in 1906 as Astronomer Royal for Scotland, to confirm the existence of star-streaming amongst these fainter stars, which extended to a greater distance from the sun than the stars used by Kapteyn.

The work on the Groombridge Catalogue directed Dyson's attention to the problems of stellar motions, in relation to the distances and luminosities of the stars and to their distribution in space. Both whilst at Edinburgh and after his return to Greenwich in 1910 as Astronomer Royal, on the retirement of Sir William Christie, he published a number of papers on these subjects.

As chief assistant, Dyson had also taken a considerable part in the Greenwich share in the international co-operative plan for photographing the

heavens and preparing an astrographic catalogue: the zone of the sky allotted to Greenwich was from declination 65° N. to the pole. On his return to Greenwich as Astronomer Royal, many of the programmes of work were directed to making the information about this zone of the sky as complete as possible. Measurement of the parallaxes of stars of large proper-motion, determinations of photographic magnitudes and of effective wave-lengths were undertaken. The whole zone was photographed again, the photographs being obtained through the glass; by placing corresponding early and late photographs film to film, the proper-motions of the stars were conveniently and rapidly derived from differential measures.

The problems to be solved at total eclipses of the sun claimed much of Dyson's attention. He took part in several himself and was fortunate in never having cloudy weather. In the total eclipse of 1927, which was visible in England, he selected Giggleswick as the station for the Greenwich party, and this proved to be almost the one place where the eclipse was observed under favourable conditions. His own work on the spectra of the chromosphere and of the corona made important contributions to the subject. It was in large measure as the result of his initiative and energy that two expeditions went from England to observe the total eclipse of May 1919. Dyson had pointed out in 1917 that this eclipse would afford a particularly favourable opportunity for testing whether there was a deflection of rays of light passing near the sun of the amount predicted by Einstein from his theory of relativity. Preparations were made for the two expeditions in the hope that the Great War would end in time to make it possible for them to set out. How the expeditions set out, obtained their observations and vindicated Einstein's prediction is well known. This successful confirmation, coming at so crucial a time, undoubtedly did much to bring about a general acceptance of Einstein's theory. After his retirement in 1933, Dyson wrote, in conjunction with Dr. R. v. d. R. Woolley, "Eclipses of the Sun and Moon", published in 1937, which is the best book that has been written on this subject.

Dyson took a great interest in problems of time-keeping and in the craft of clock-making. He was responsible for the distribution through the B.B.C. of the 'six-pips' time signals, the signals being sent direct from Greenwich and making accurate time more readily available than it had hitherto been. He was for many years president of the British Horological Institute, which awarded him its Gold Medal in 1928, and he was a member of the Court of Assistants of the Clockmakers Company, of which he was twice master.

After the Great War, when international co-operation in science had lapsed to a considerable extent, Dyson played a prominent part in the reconstitution of international scientific co-operation with the International Research Council and in the formation of the International Astronomical Union. The success that this Union has achieved in securing international co-operation in different branches of astronomy is in no small degree due to Dyson's wise guidance. His election as president for the period 1928–32 was a fitting recognition of his services to the Union.

Dyson received many honours. He was president of the Royal Astronomical Society, 1911–13; president of the British Astronomical Association, 1916–18; vice-president of the Royal Society, 1913–17. He was awarded a Royal Medal of the Royal Society in 1921, the Bruce Gold Medal of the Astronomical Society of the Pacific in 1922 and the Gold Medal of the Royal Astronomical Society in 1925. He received honorary degrees from the universities of Oxford, Cambridge, Edinburgh, Durham, Leeds, Toronto, Perth and Melbourne, and was foreign or corresponding member of various national academies. He was created a Knight Bachelor in 1915 and a K.B.E. in 1926.

Dyson was a man of engaging personality and of singular charm. To all of his staff he was not merely a chief but also a friend. He married Caroline Best, daughter of Mr. Palemon Best; she died in March, 1937. They had two sons and six daughters. Foreign astronomers from all parts of the world and many other visitors to Greenwich were sure of a warm welcome and of friendly hospitality in their home. Dyson had a keen sense of public duty, and much of his leisure time was spent in work for the various schools, hospitals, charities and other good causes in which he was interested. Of no man might it more appropriately be said:

"His life was gentle, and the elements
So mix'd in him that Nature might stand up
And say to all the world 'This was a man!'"

H. S. J.

Engineer Vice-Admiral Sir Henry John Oram, K.C.B., F.R.S.

Of the many engineers who held high positions during the Great War, none had a more onerous and responsible task than Engineer Vice-Admiral Sir Henry Oram, who died at Cranleigh on May 5 at the age of eighty years. From October 1907 until June 1917 he was engineer-in-chief of the Fleet, and as such was responsible for the design, construction and maintenance of the machinery of hundreds of warships from battleships to armed trawlers, and for a personnel of something like 70,000–80,000 officers and men. He had served in various grades at the Admiralty from 1884 until 1907, when he succeeded Engineer Vice-Admiral Sir John Durston and "under him", as *The Times* said, "was created the post-Dreadnought Fleet, which formed the backbone of the Navy in the conflict with Germany, and the very high standard of efficiency obtained under the stress of war in the engine rooms of ships of all types and classes reflected the highest credit upon his professional skill, sound judgment and administrative ability".

Though, unfortunately, little has been published on the work of the engineering branch of the Navy during the Great War, both Admiral Jellicoe and

Admiral Beatty paid tribute to the high standard of efficiency maintained in the engine rooms of His Majesty's ships under difficult conditions.

Oram was a product of the eminently successful system of training introduced by the Admiralty about a century ago, whereby a boy with no other advantages than those of character and physique could climb to the top of the ladder. He was born on June 19, 1858, and at the age of fifteen years entered Devonport Dockyard as an engineer student; during the next six years he passed through the engine and boiler shops, the foundry, the smithery, the drawing office and so forth, meanwhile attending the Dockyard School. In 1879 he passed for an assistant engineer R.N. and then entered upon three further years training at the Royal Naval College, Greenwich, where at that time the staff included Hirst, Cotterill, Reinold, Hearson, Waghorn, White and W. E. Smith, while among Oram's fellow students were Rear-Admiral F. T. Bowles, U.S.N., and Rear-Admiral Miyabara, afterwards the engineer-in-chief of the Japanese Navy. From Greenwich Oram passed out with the highest distinction, and for the next two years, 1882–84, served afloat in the Indian troopships *Crocodile* and *Malabar*, the running of these and their sister ships being looked upon as the best experience for junior engineers. This proved to be Oram's only sea service, for in 1884 he was appointed to the staff of Sir James Wright at the Admiralty and never again left Whitehall.

To detail the many developments with which Oram was associated would be to trace the progress of naval engineering during the course of forty years. When he entered the Navy there were plenty of ships with horizontal simple-expansion engines working with steam at 30 lb. pressure; when he retired the standard type of machinery was the geared steam turbine working with steam at about 250 lb. pressure generated in oil-fired water-tube boilers. He was associated with all the troubles over forced draught, and by his invention of the "Admiralty" boiler-tube ferrule helped to mitigate some of them; he saw the introduction and development of the splendid triple expansion engines of last century; he was already in a responsible position when the various types of water-tube boiler—Thornycroft, Yarrow, Normand, Babcock and Wilcox, Dürr, Niclausse, Belleville, etc., were being installed, and he attended the trials of the historic *Turbinia*, and saw the turbine supersede the reciprocating engine for all warships.

There was nothing meteoric in Oram's rise to the top of his profession. He passed through all the grades of assistant engineer, engineer, chief engineer, etc., and in 1903 when the new titles were introduced he became an engineer-rear-admiral. He was made a C.B. in 1906, a K.C.B. in 1910, and his scientific attainments were fully recognized by his election in 1912 as a fellow of the Royal Society. He was the first naval engineer to be so honoured. In 1915 he was elected a member of the Athenæum under Rule II.

Besides his work at the Admiralty, Oram lectured on marine engineering at the Royal Naval College, Greenwich, and he practically rewrote the admirable text-book on the marine steam engine, first published by Richard Sennett, the engineer-in-chief from 1887 until 1889. In 1908–9 he served as president of the Junior Institution of Engineers and in 1914 of the Institute of Metals, giving to both societies very valuable addresses. At the jubilee meeting of the Institution of Naval Architects he contributed a paper entitled "Fifty Years' Changes in British Warship Machinery". Though not like his predecessor Sir John Durston, or his immediate successors Sir George Goodwin and Sir Robert Dixon, a president of the Institute of Marine Engineers, his name appears among the honorary members. From the United States he received the Distinguished Service Medal.

Since his retirement Admiral Oram had lived at Rudgwick and he was buried in the churchyard there on May 8.

EDGAR C. SMITH.

Mr. Daya Ram Sahni, C.I.E.

WE regret to record the death of Rai Bahadur Daya Ram Sahni, the distinguished Indian archæologist, formerly director-general of the Archæological Survey of India, which took place at Jaipur in March at the age of sixty years.

Sahni was educated at the University of the Panjab, and was one of the first to hold a Government of India scholarship in archæology. He was also a gold medallist of his university. He joined the Archæological Survey as scholar and assistant in 1904, reaching the grade of superintendent in 1917. He was a regular contributor to the records of the Survey, dealing more particularly with the decipherment of inscriptions and describing Buddhist sites. He is the author of two well-known and authoritative works on the Buddhist remains at Sarnath; and he contributed two chapters to Sir John Marshall's great work on Mohenjo-daro and the Indus civilization. Sahni was appointed deputy-director of the Archæological Survey in 1925, and director-general in 1930, retiring in 1935, when he received the honour of C.I.E. On his retirement he accepted the offer of the appointment of director of archæology from the Jaipur Government and was responsible for excavations at Bairat, one of the most important sites in Jaipur, publishing a report on his results.

WE regret to announce the following deaths:

Sir George Kendrick, who was actively associated with the development of the University of Birmingham, where he endowed the Poynting chair of physics, on May 28, aged eighty-nine years.

Sir William Lobjoit, O.B.E., during 1920–27 controller of horticulture at the Ministry of Agriculture, on May 28, aged seventy-nine years.

Dr. C. H. Mayo, founder with his brother of the Mayo Clinic, Rochester, Minnesota, for surgical research, and regent of the American College of Surgeons in 1913–36, on May 26, aged seventy-three years.

News and Views

Prof. W. E. Le Gros Clark, F.R.S.

PROF. WILFRED E. LE GROS CLARK, whose appointment to the chair of anatomy at University College, London, vacant since the sudden death of Prof. H. H. Woollard in January last, will take effect as from October 1 next, has been professor of anatomy in the University of Oxford since 1934. Born on June 5, 1895, he was educated at Blundell's School, Tiverton, and passed through the Medical School of St. Thomas's Hospital, London, where he was a pupil in anatomy of Prof. F. C. Parsons, well known as an anthropologist, and an authority on the physical characters of the peoples of Britain. During the Great War, Prof. Clark served in the R.A.M.C. with the rank of captain, and after demobilization was for two years principal medical officer of Sarawak, Borneo. He returned to England in 1922 and in 1924 became reader in anatomy in the University of London. Three years later, in 1927, he was appointed to the chair of anatomy at St. Bartholomew's Hospital, London, transferring to the chair of anatomy at St. Thomas's Hospital in 1930 on the retirement of Prof. Parsons. Apart from his contributions to anatomical and medical journals, Prof. Le Gros Clark is the author of a number of authoritative studies on anthropological topics, including more particularly the physical characters of the Eskimo and the comparative morphology of early man and the anthropoids, his most considerable contribution to discussion of the latter being his "Early Forerunners of Man", which appeared in 1934.

Dutch Congress of Natural Science and Medicine

IN NATURE of May 27, p. 908, reference was made to the Dutch Congress of Natural Science and Medicine held at Nijmegen on April 11–13. A correspondent has sent the following notes on some of the medical papers. On the first day of this Congress the main medical paper was read before a very large audience by Prof. B. Brouwer, of Amsterdam. Prof. Brouwer spoke on the hydrodynamic intra-cranial and intra-vertebral conditions in connexion with the development of modern neuro-surgical diagnostic and operative technique. He showed very clearly the great importance which is attached to very simple physical examinations of the cerebral fluid and the ventricular system for the localization of intra-cranial and intra-vertebral space-occupying lesions. Prof. Brouwer stressed the point that ventricular estimation and ventriculography—when in safe hands—are of the greatest value for the early diagnosis of many intra-cranial space-occupying lesions. Dr. A. Biemond, of Amsterdam, spoke on the diagnosis of mid-line brain-tumours. Going over a list of the ante- and post-mortem findings of twenty mid-brain tumour cases, Dr. Biemond tried to divide this material into three groups, according to their clinical picture and their operability. The prognosis, however, of mid-brain tumours, even in the light of modern neuro-surgery, is not very hopeful, according to Dr. Biemond's experience. Very much in contrast with this paper was the contribution of Dr. F. Verbeek, of Groningen. Dr. Verbeek described the tremendous advances which have been made during the last twenty years in the neuro-surgical field. A review of his neuro-surgical patients gave much more hope that even the mid-brain tumours will be accessible for operative treatment. Dr. A. Brouwer (Eindhoven) spoke on the technique of X-ray photography. Dr. C. E. Burger (Eindhoven) dealt with X-ray photography as a method for mass examination in the attack on tubercular infection. Dr. J. H. van der Tuuk (Eindhoven) spoke on deep X-ray treatment and its measurement, with reference to apparatus operating up to one million volts.

Teachers in Technical Institutions

IN his presidential address at the annual conference of the Association of Teachers in Technical Institutions on May 29, Dr. E. A. Seeley commended the Spens Report as establishing the parity in status and value of the education given in junior technical schools with that given in 'grammar' and other post-primary schools, but blamed it for disparaging the cultural potentialities of junior commercial and household science schools. These should be given the opportunity of showing that they are capable of developing "on a broad scientific and realistic basis" an education equal in cultural as well as vocational value to that of the schools associated with engineering and building. Referring to the report presented to the Board of Education six months ago, without apparent result, on scholarships for students in technical colleges, Dr. Seeley urged that the nation cannot afford to let willing and competent students be kept from attendance at these colleges by lack of means, while allowing the places that should be occupied by them to be filled by anyone whose parents happen to be able to pay his fees. As regards relations with other associations of teachers, the hopes entertained last year of a workable scheme of federation are for the time being in abeyance. The address closes on the note "education for service"—the sense of responsibility of teachers to the community and the necessity of realizing the social implications of their work: they must train in citizenship as well as in technology.

Indian Education, Past and Present

THREE lectures on "Some Aspects of Indian Education, Past and Present" by Sir Philip Hartog, sometime vice-chancellor of the University of Dacca and president of the Auxiliary Committee of the Indian Statutory Commission on the Growth of Education of 1928–29, have recently been published

in the "Studies and Reports" series of the University of London Institute of Education (London: Oxford University Press. Pp. 110. 3*s*. 6*d*.). The lectures, originally delivered in 1935, have been revised and brought up to date and supplemented with memoranda designed to remove, if possible, the imaginary bases for the accusation made by Mr. Gandhi and others that the British Government systematically destroyed an indigenous system of elementary schools and with it a literacy which the schools are presumed to have created. Among the many factors which have militated against the success of Indian educational policies, Sir Philip stresses the extreme lengths to which the policy of devolution was carried with a blind faith that local bodies would learn by making mistakes, the amenability of the Government to pressure exercised by the vocal middle classes in favour of diverting to secondary and higher education funds which ought to have gone to primary education, the extent to which universities have been financially dependent on examination fees and the overcrowding of universities with students who ought never to have been admitted. It has been said that the nineteenth century Liberal thought he knew the final truths about education and failed to recognize that it must serve the community as well as the individual. Sir Philip mentions several hopeful indications, including the work of the social service leagues which he helped to establish at Dacca, of the springing up in Indian educational circles of a new spirit of service to the community.

The Carnegie Corporation of New York

THE report of the president of the Carnegie Corporation of New York, Frederick P. Keppel, for the year ended September 30 records the distribution of grants amounting to nearly four million dollars (including nearly half a million from the Corporation's British Dominions and Colonies Fund) in the following proportions: endowment and support of universities, colleges and schools 22, the arts 17, library interests 15, research studies and publications 14, adult education 5, miscellaneous 27 per cent. It is a document of outstanding interest to trustees and administrators of funds for educational, scientific and cultural purposes and to prospective benefactors and beneficiaries. Highly important questions of principle and policy are lucidly and briefly discussed under the headings "The Public and Foundations", "Funds for Philanthropy" and "Board Procedure". It appears that whilst the volume of large gifts and bequests, derived as they are from fortunes made under conditions which are unlikely to recur, tends to diminish, the funds of the various community trusts made up of relatively small individual contributions have grown steadily in the past ten years from sixteen to fifty million dollars, and the president believes that "current contributions from public funds, from industry and commerce, plus the cumulative contributions of private endowments, are together taking over a steadily increasing share of the total load" of the finance of educational, scientific and cultural enterprises.

Training for Citizenship

A REVIEW of the Corporation's experience in the field of general education leads to some interesting reflections on the present status and influence of the Graduate School (that "sacred cow in American education, to be worshipped rather than studied, understood, and improved") and the extent to which students destined for the professions are truly educated in the sense of being prepared for life. Their education must, it is contended, "give far more consideration than it does at present to the place of the professionally trained men and women in a modern community, the place that such men and women might take *as a united group*, not divided and weakened in their influence as at present by an *over-emphasis on the spirit and traditions of the separate professional guilds*". While education cannot alone create an aristocracy of trained intelligence, it can have regard to such an ideal and foster attitudes that would lead professional men and women to work together rather than separately in contributing to the solution of our political and social problems.

Lines of Magnetic Force

PROF. C. COLERIDGE FARR, of Canterbury College, Christchurch, New Zealand, has sent a communication in which he advocates the preparation of accurate charts showing the lines of magnetic force running from the south magnetic pole to the north magnetic pole. Prof. Farr points out that the secular change in declination at any observing station is the parallactic angle subtended by the movement of either pole as viewed along a line of magnetic force, and he considers that the comparison of charts, showing the lines of force at different epochs, would lead to a better understanding of the nature of secular variation. The lines of force could be sketched in on existing declination charts, but there would be obvious difficulties in drawing the lines all the way from pole to pole. In forwarding Prof. Farr's letter H. F. Skey, director of the Magnetic Observatory, Christchurch, N.Z., directs attention to the smoothed charts of such lines given by A. G. McNish in *Terrestrial Magnetism*, **41**, 37 (1936). The question is whether unsmoothed charts on a large scale would be sufficiently reliable and sufficiently useful to justify the cost of publication.

National Museum of Wales

AT a Court of Governors of the National Museum of Wales held at Aberystwyth on May 23, Lord Harlech from the chair reported on the result of his recent visit to the United States of America, when he was accompanied by Sir Cyril Fox, the director, to appeal to Welshmen in the States on behalf of the National Museum. The sum of £10,000 has already been received in response to the appeal. Lord Harlech stated that the attitude of Welsh Americans towards the Museum was such that the response would have been much greater had it not been for the international tension in Europe at the present time. The variety and range of the recent accessions to the collections of the Museum

which were reported to the governors by Sir Cyril Fox on this occasion, are an indication of the activities of the Museum in the preservation and display of objects illustrating the history and culture of the Welsh people. Among these were a collection of neolithic finds from Breconshire, a thirteenth–fifteenth century stone fireplace from the Vale of Glamorgan, and a turned chair of mid-sixteenth century date; while among objects deposited were an important collection of carved stones dated at about A.D. 1230–40 from Castell-y-Bere, and the extremely interesting iron age fire-dog found in 1852 at Carreg Coedog Farm, Denbighshire. It was also reported that the services of the Museum had been called upon by the Office of Works to report on the antiquities of Pembrokeshire, which are threatened by a tank school.

Inland Water Survey Report

THE third annual report of the Inland Water Survey Committee, issued by the Ministry of Health and the Scottish Office (H.M. Stationery Office, 4*d*. net), while recording a year of useful activity in various directions, chiefly with the aid of external agencies, finds occasion to express disappointment at the results achieved and to state the conviction of the Committee that action should be taken by the Government, financially or otherwise, for ensuring the extension of the work in both England and Wales and Scotland. The Committee points out that it has no staff at its disposal for taking actual measurements, and that it has to rely in England and Wales (and to some extent in Scotland) on voluntary action by catchment boards and others for the execution of this part of the work of the Survey. It finds, moreover, that relatively very few suitable records of river flow are being kept, and that neither the information available from water undertakers, nor that from catchment boards, is sufficient in scope or adequate in quality to enable a comprehensive survey to be made. It is convinced that in order to be of real use, such a survey should be carried out on similar lines to the Ordnance Survey or the Geological Survey in their respective fields. It may be pointed out that this was precisely the view taken by the British Association Committee four years ago, when the Government reluctantly agreed at its instance to institute a survey.

As regards the actual progress made with the Survey, the examination of river basins, begun in the first and second reports, has been continued, and the results of the investigation of the river basins of the Earn (Perthshire), Eden (Fife), Tyne (East Lothian), Trent, Great Ouse, Wye and Nith (Dumfriesshire) are described in the report. During the year, the Department of Agriculture for Scotland was authorized to spend £500 on the equipment and maintenance of river discharge measurement stations. The existing level-indicating and recording stations on the Clyde, Kelvin, Irvine and Tay have been maintained and stations established on the Earn, Eden, Tyne and Nith. The Tweed basin has also been reconnoitered. In the sphere of underground water, the field work carried out by the Geological Survey in the Nene basin has been continued, and work is proceeding on a memoir dealing with the underground water resources of an area which includes Northampton and Oxford. The results of measurements for twenty-eight gauging stations in fourteen river basins, collected by various authorities, have been published as "The Surface Water Year Book of Great Britain, 1935/6". The report also deals with several technical difficulties which have been met with during the process of collecting these statistics, and recommendations are made about recording charts and arrangements for securing accuracy of measurement.

Scientific and Industrial Research in New Zealand

AN admirable survey of the work carried out under the Council of Scientific and Industrial Research, New Zealand, during 1927–38 has been issued by the Department as Bulletin No. 69. It includes accounts of work carried out by the Dairy Research Institute, the Plant Research Bureau and the Wheat Research Institute, as well as of the activities of the Department in soil survey, fruit research, animal research, tobacco research and the work of the research associations. The work of the Dairy Research Institute on the cause and control of openness in cheese is described in some detail, as well as further work on discoloration in cheese, and on cheese manufacture. Reference is made to the work of the Plant Diseases Division on chemical sprays and the spray certification system which has been introduced, as well as on virus diseases of tobacco, tomato and of potato, and the importance of the methods introduced for the control of smut of barley. The contribution of the Wheat Research Institute to the improvement of the technique of wheat growing and harvesting, the growing of varieties most suitable for special districts, and cheapening the cost of production is emphasized, as well as the selection and distribution of a new wheat, Cross 7, which yields as well as standard varieties, and has by itself a baking quality equal to that of the old varieties plus the proportion of Canadian wheat formerly used. Fruit research has covered manurial experiments on fruit tree nutrition, boron as a cure for internal cork of apples, orchard sprays, wrappers for fruit; and the soil survey studies have included reference to the physiological diseases of plants. An important discovery in the field of animal research relates to the wasting diseases caused by deficiencies in the diet of cobalt, to which the bush sickness in the North Island, Morton mains disease in the South Island, and Glenhope ailment in Nelson are due.

Commercial Applications of Blended Light

IN practical work, the term 'blended light' is used to describe the mixture of the light from the ordinary tungsten gas-filled lamps with that from mercury discharge lamps. A. H. Olsen contributes a paper to the *Electrical Review* for May 26 in which he discusses the blending of the light from these lamps. A gas-filled lamp depends on the light emitted by a tungsten

filament; it therefore produces a continuous spectrum, red being prominent, but lacking in blue. The resultant colour is yellowish. A mercury lamp depends on the excitation of vapour and consequently emits a light with a broken spectrum, red rays being almost completely absent and blue being very pronounced. If the two light sources are mixed in the proper proportions, we get an approximation to white light. The effective application of this to shop lighting depends on the type of goods displayed; so no definite ratios of the two lights can be fixed and each installation is examined experimentally. In the case of drapers, furnishers and outfitters, where fabrics are displayed, the proportion of tungsten lumens to mercury lamp lumens is generally in the proportion of three to one. In practice, this means utilizing one 80-watt mercury lamp with two 200-watt tungsten lamps. When this is done, the colours of the fabrics appear much the same as with daylight. Black appears of a richer lustre, and red shades do not appear mauve as they do under mercury light. Although the consumption of electricity might have been expected to be less than if only tungsten lamps were used, it is found that owing to the amount of tungsten light required to blend with the mercury light, the consumption is much the same. In most of the main town shopping centres, blended light installations present a striking contrast to competitive windows in the same area, being much more prominent and displaying the goods more effectively.

Bureau of American Ethnology, 1937–38

ALTHOUGH the normal activities of the Smithsonian Institution have been curtailed of recent years owing to economic conditions in the United States, the Bureau of American Ethnology has been able to maintain its operations in the field, and even to extend them in archæology, owing to the provision of Federal finance and the supply of labour made available by measures for relief. A summary statement of the research carried out by members of the staff in the period 1937–38 is given in the fifty-fifth annual report (Washington, D.C., 1939. Pp. 8) covering that statistical year—an exiguous document in comparison with the more elaborate accounts familiar to anthropologists in earlier years. A major work of archæological excavation was that of the Lindenmeier site in Colorado, where Dr. F. H. H. Roberts, jun., has continued the work of exploration of the habitation site of Folsom man which he initiated in 1934. His operations in the summer of 1937 uncovered an area of 2,800 sq. ft., and 735 specimens were obtained, including a number of new types of stone implement. Early in the season 1938 evidence of the artistic effort of Folsom man, "one of the earliest known of New World inhabitants", came to light in the form of pieces of bone with attempts at engraved design. An interesting investigation approaching completion is Dr. John R. Swanton's research on behalf of the United States De Soto Expedition Commission, of which he is chairman. It involved one field expedition in the year, when Dr. Swanton visited Alabama for the purpose of examining old Indian town sites which might possibly be identified with those mentioned by De Soto. An extended ethnological exploration of western South America has been planned, which was initiated when in April last Dr. J. H. Steward left Washington for Ecuador, where he has since been at work among the highland Indians.

Britain in the Dark Ages

THE northern sheet of "The Map of Britain in the Dark Ages" (Ordnance Survey Office, Southampton, 1939. Pp. 43. Price 5s. net) is, if possible, of even greater interest than the southern sheet issued by the Ordnance Survey in 1935. This is not least, perhaps, because it serves to emphasize the imperfections in the material, while affording suggestion of the more urgent provinces to which further research should be directed, if any substantial advance in knowledge is to be made. Thus, for example, brochs and earth-houses do not appear here, being reserved for future separate treatment, owing to the difficulty of determining their chronological relation to the period covered by the map. This period, roughly, is from A.D. 440 to 840, an approximation to the date of the union of the kingdom of Picts and Scots under Kenneth, son of Alpin. In regard to technical details, the scale of the map is 1 : 1,000,000. The practice in the use of symbols of archæological maps previously issued by the Survey is maintained, the form of the symbols suggesting the objects, additions being made to the symbols already in use as required, as, for example, in indicating the distribution of Pictish symbols. An expository introduction deals with certain broad questions—the extent and location of the British, Scottish, Pictish and Anglian regions, the distribution of tribes, the lines of early roads, and the like. The section in which the roads are traced is a particularly instructive synthesis of geographical and archæological argument, although the editor modestly disclaims any attempt at original research and professes to do no more than record existing knowledge. The discussion of the range of distribution of the ethnic groups brings out very markedly the need for both a systematic survey of Scottish place names and of systematic excavation, directed to specific ends, mainly chronological.

Tribute to the Memory of Sir Victor Horsley

SIR VICTOR HORSLEY was far from being merely a great surgeon. His death while still in the full plenitude of his powers deprived the world of a remarkable personality which expressed itself effectively in many fields, and his old friend and fellow-worker, Mr. C. J. Bond, has done well to place on record personal notes ("Recollections of Student Life and Later Days". 1939. H. K. Lewis and Co. Pp. 48) of an association lasting forty years. Neuro-psychical phenomena held an irresistible attraction for both men, and in elucidating Horsley's share in some of their conjoint work, Mr. Bond outlines some of the conclusions to which he was led by these and other independent researches the scope of which is indicated by his query: How has it come about that the neural machinery exists for the carrying out of neuro-psychical activities in a dual manner while on the psychical side the more

highly organized, later evolved responses are perceived and executed by a unified consciousness and a single will? Of Horsley's activities in the political and sociological sphere he observes, "He clearly realized that what the world sorely needs is a deeper and wider recognition of the fact that selfishness and the aggressive spirit, although they no doubt had some survival value among primitive peoples and savage tribes, yet under modern conditions of so-called civilization they act as brakes on the wheels of human progress".

School Natural History

PESSIMISTS who lament the alleged lack of interest shown by the modern schoolboy in natural history should read the current annual reports of two famous school natural history societies—the reports for 1938 of the Marlborough College Natural History Society and of the Rugby School Natural History Society. Each of these societies has existed long enough for its usefulness to be thoroughly tested, for the Marlborough report is the eighty-seventh, the Rugby one the seventy-second, and the internal evidence is that enthusiasm abounds and observations are made over a wide range of natural history subjects. The two societies seem to be run on quite different lines. At Rugby, activities centre in thirteen specialist sections, which arrange their own discussions and excursions, and meet in common only at the general lectures given by outside speakers. At Marlborough, there appear to be no lectures by outsiders, the members themselves are the lecturers, and there are but two sections, archæological and natural science. This arrangement, while encouraging more general distribution of interests, has not affected the specialist labours of the members, for it is a remarkable record that from the pages of successive reports no fewer than seven hand-lists have been published, giving a wonderfully complete conspectus of the fauna and flora of the Marlborough district.

The Science Library

THE first part of a fifth edition of the "Hand List of Short Titles of Current Periodicals in the Science Library" (H.M. Stationery Office. 9*s*. net) has recently been issued. The new edition contains about nine thousand main entries with about four thousand cross references from alternative headings, as against four thousand titles in the fourth edition, issued in 1926. Publications of learned societies and institutions are entered under the names of their permanent seats, and publications of Government departments and other bodies under the name of the countries from which they derive their denominations, or, for want of such denominations, under the places whence their acts are issued. The Hand List is not intended as a bibliographical catalogue; it gives merely brief titles of the publications with details of the Library holdings. The List is being issued in two parts, of which the first is arranged alphabetically. It is hoped later to publish a second part with a subject arrangement. The preface to the List gives a very brief but lucid description of the Science Library and its development.

New Medical Journals

THE first numbers of two new scientific journals have been received. (1) *Anais da Faculdade de Medicina de Pôrto Alegre*, Universidade de Pôrto Alegre, Brazil, Fasc. 1, pp. 1–303. This is handsomely produced and well illustrated, and the papers, in Portuguese, Spanish, Italian, French, German or English, have summaries in French, German and/or English. It opens with an account of the medical centre of the University, and contains papers, among others, on detachment of the retina (Arruga), hereditary ophthalmic diseases (Meyer), and feminine types (Gomes). (2) *Anales de la Escuela Nacional de Ciencias Biologicas*, Mexico, vol. 1, No. 1, pp. 1–178. This also is well produced and illustrated, and contains articles in Spanish on the cultivation of *Rickettsia* of typhus fever (Siegfried), histology of the poison gland of a spider, *Crypsidromus* (Ancona), calcium chloride in the treatment of scorpion poisoning (Varela), a new species of *Phlebotomus* (Dampf) and some Mexican textile fibres (Huerta and Ancona) and others. Summaries in English and German are provided. In both journals, the printed matter on a page measures about 8 in. × 5 in.

Journal of the Royal Agricultural Society

THE ninety-ninth volume of the *Journal of the Royal Agricultural Society of England* has now been published (price 15*s*.). It includes, as in the previous volume, "The Farmer's Guide to Agricultural Research", which this year contains an additional section on pests and parasites. As usual, the subjects of the special articles cover a wide field of interest. Agricultural long-term credit facilities in Great Britain are discussed, and farm organization on the silt soils of Holland, Lincolnshire, described. A detailed account is also given of the life-history, distribution and control of bracken, from which there can be no doubt as to the need for urgency in undertaking means for its eradication. The starling is the subject of a further article, and at present it seems uncertain whether it should be regarded as a friend or enemy of the farmer. The Warnford Farm Estate, where pig breeding and bacon production are carried out on a vast scale, has been selected as this year's "Notable Farming Enterprise".

Durban Museum and Art Gallery

UNDER the directorship of E. C. Chubb this combined institution continues to make steady progress, reflected in an increase of visitors, who in the year ending July 31, 1938, numbered 123,771. The educational value of the collections is increased by the lectures to the public and to school children delivered by the staff, and modern developments are shown in the appointment of a guide-lecturer, through the generosity of the Carnegie Corporation of New York, the extended use of cinematograph films to illustrate museum lectures, and the scheme which enables assistants to visit other South African museums for the purpose of gaining experience in museum technique, a scheme sponsored by the South African Museums Association.

Applied Psychology in Italy

A PERMANENT Commission for the Application of Psychology has recently been appointed by the Italian National Board of Researches. It aims at promoting among State institutions, labour organizations and private persons the application of psychology in any field, with regard to selection and orientation, as well as to the organization of work. At present, applications in the scholastic field, where professional orientation has become a function of the school, are being studied in the first place; applications in industries, aviation and public transport will follow. The president of the Commission is Prof. P. Agostino Gemelli.

Appointments for Research in Tropical Medicine

THE Medical Research Council is offering up to three junior fellowships to qualified medical men or women wishing to receive training with a view to careers in research work in tropical medicine. The fellowships will be tenable for three years. The stipend will be at the rates of £300, £400 and £500 per annum in the successive years, with an additional allowance during service abroad and necessary expenses. In three years' time, at least one senior fellowship will be available for candidates who have held the junior fellowships mentioned above. This will be awarded for a further period of three years, carrying stipend at the rate of £600–£750 per annum, with an additional allowance during service abroad and expenses. The Council is also prepared to consider immediate applications for senior fellowships from candidates who have had adequate experience in research work, whether already specially trained in tropical medicine or not. The Council further intends to establish in due course, as suitable investigators become available as the result of the fellowships scheme, permanent and pensionable appointments for research work in tropical medicine, including senior posts. Further information can be obtained from the Secretary, Tropical Medical Research Committee, 38 Old Queen Street, London, S.W.1, with whom applications should be lodged not later than June 19, 1939.

Announcements

SIR EDWARD MELLANBY, secretary of the Medical Research Council, will deliver the annual Stephen Paget Memorial Lecture of the Research Defence Society on the occasion of the Society's annual general meeting, to be held at the London School of Hygiene and Tropical Medicine on June 13. The title of Sir Edward's lecture will be "The Experimental Method in the Conquest of Disease".

THE seventy-sixth annual general meeting (Murdoch Centenary) of the Institution of Gas Engineers will be held on June 6–9 at the Institution of Civil Engineers. The Murdoch Centenary Lecture will be delivered on June 6 by Dr. E. F. Armstrong.

THE Council of the Institution of Naval Architects has accepted an invitation of the Gesellschaft der Freunde u. Förderer der Hamburgischen Schiffbau-Versuchsanstalt to participate in an International Meeting of Shipbuilders, Marine Engineers and Nautical Experts to be held in Hamburg in June. A visit will be paid to Kiel at the invitation of the German Navy, and two days will also be spent in Berlin under the auspices of the Lilienthal-Gesellschaft für Luftfahrtforschung and of the Schiffbautechnische Gesellschaft.

THE Cambridge University Press has in active preparation, and will publish early in the autumn, the authorized biography of the late "Lord Rutherford", by Prof. A. S. Eve, a personal friend for many years and formerly Macdonald professor of physics at McGill University. The author has enjoyed the fullest co-operation of Rutherford's closest colleagues and friends, and of Lady Rutherford, who has allowed use to be made of the collection of her husband's letters and papers. Earl Baldwin has written a foreword.

THE Institute of Ethnography attached to the Academy of Sciences of the U.S.S.R. is preparing an ethnographical work on the different peoples of the U.S.S.R. which will run into many volumes. The first three volumes are to be ready this year, and will be devoted to a description of the peoples of Central Asia and Kazakhstan, Siberia and the Far East, and the European section of the Soviet Union. The Institute for Soil Study of the Academy has just published the first three volumes of a monograph on "Soils of the U.S.S.R.". These volumes contain a geographical description of the soil of the European part of the U.S.S.R. from the far north to the Caucasus. A fourth volume, dealing entirely with the soils of the Caucasus, will be issued this year.

THE German Society of the History of Medicine, Natural Science and Technique will be held this year at Jena on September 21–24, when the chief subjects for discussion will be the eye in the history of medicine, natural science and technique. There will also be an exhibition of historical collections in Jena and Weimar.

ELEVEN thousand fewer persons were killed in accidents of all kinds in the United States during 1938 than in 1937—a decline of more than 10 per cent. Motor-vehicle fatalities declined from about 40,000 in 1937 to between 31,000 and 32,000 in 1938.

PRELIMINARY figures from the census taken in Soviet Russia last January give the U.S.S.R. a population of 170,126,000. The increase since 1926 is 23,100,000, which is approximately equal to the population of Spain. In Moscow the birth-rate was 69 per cent higher in 1938 than in 1936: the death-rate for the entire country has dropped by more than 40 per cent compared with 1913. The census shows that the total number of industrial workers employed in the U.S.S.R. rose from 11,600,000 in 1928 to 27,800,000 in 1938. The entire population has more than doubled since 1926.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 944.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Mechanical Device for Smoothing Data

As is well known, the application of any reasonably satisfactory formula for the smoothing of a lengthy series of data involves a considerable amount of time and labour. In a recent article[1], I indicated the possibility of constructing a mechanical device whereby all mathematical computation would be eliminated. Such a machine has now been constructed.

The model (Fig. 1), capable of dealing with 18 datum points, consists of a mounted wooden board to which are attached 18 movable glass cylinders, each about 50 cm. in length, half-filled with mercury. A cylindrical iron rod with a hole near its upper end floats in each cylinder. The floating rod acts as a perfect spring, since the force it exerts is directly proportional to its vertical displacement from its position of equilibrium.

A suitable scale is pasted along the top portion of the wooden board, and the process of obtaining a smooth curve, which can be read off from the scale, is extremely simple. For purposes of illustration, the Central Cape annual rainfall figures during the years 1881–98 were employed. Starting from the left, the first cylinder is adjusted so that the hole in the freely floating iron rod corresponds to the 1881 rainfall, which was 136 per cent of the normal. If all the other cylinders are similarly adjusted to correspond with the rainfall figures of their respective years, and if a string be passed through the 18 holes in succession, the string will in effect be an unsmoothed graph of the rainfall for the period under consideration (Fig. 1).

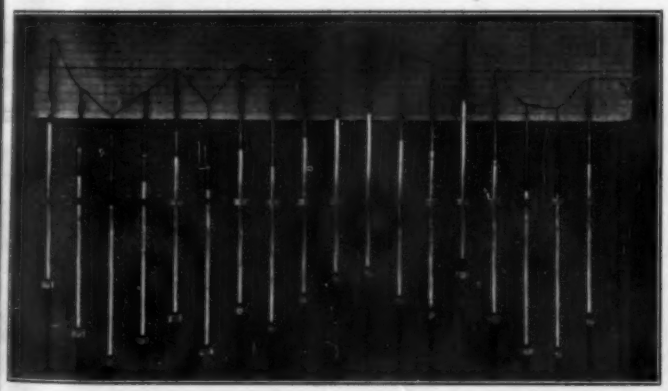

Fig. 1.

Fig. 2.

The string is attached to a movable hook on the left, and at the right it passes over a pulley, which can also be moved up and down. Tension is now applied to the string by suspending a predetermined weight (depending upon the degree of smoothness desired) to its free end, the hook on the left and the pulley on the right being adjusted so that the first and last portions of the string are horizontal. Evidently the effect of the tension on the string will be to displace the iron rods in such a way that a smoothed curve results (Fig. 2). (This photograph was taken at an angle so as to reduce the apparent width of the board.)

The points on the smooth curve may now be read off from the scale, thus reducing many hours of laborious calculations to a few minutes. Moreover, once the cylinders have been adjusted to fit the original data, curves of varying degree of smoothness may be obtained in a minimum of time simply by attaching different weights to the free end of the string.

With reference to the theory underlying this mechanical process, the machine automatically applies a very interesting type of graduation formula to the crude data. In any smoothing process some departure from the observed facts is essential, and in general a compromise must be struck between departure from the observed facts and the smoothness of the resulting curve. If $y_1 \ldots y_n$ be the crude data, and u_1

. . . u_n the corresponding smoothed values, then $\sum_1^n (y_r - u_r)^2$ may be regarded as a measure of the departure from the observed facts, and the sum of the squares of the first differences, that is, $\sum_1^{n-1} (u_{r+1} - u_r)^2$ may be regarded as a measure of the lack of smoothness or the roughness of the resulting curve. If these definitions be accepted, then the logical way to carry out the smoothing process would be to make k times the sum of the squares of the deviations of the data from the graduated curve plus the squares of the first differences of the graduated curve a minimum, where k is an arbitrary constant. This means that :

$$k\sum_1^n (y_r - u_r)^2 + \sum_1^{n-1} (u_{r+1} - u_r)^2 = \text{minimum}.$$

Application of this minimum principle leads to the result (*loc. cit.*)

$$u_r = \frac{2p-1}{p^n-(1-p)^n}\left\{\varphi_{n-r+1}\sum_1^r \alpha^{r-s}\varphi_s y_s + \varphi_r \sum_{r+1}^n \alpha^{s-r}\varphi_{n-s+1}\, y_s\right\}, \quad (1)$$

which is the formula by which the u's are expressed in terms of the crude data, α, p and φ being defined as follows :

$$\alpha = \frac{1}{2+k}; \; p-p^2 = \alpha^2; \; \varphi_r = \frac{1}{\alpha+p}\left\{p^r + \frac{p}{\alpha}(1-p)^r\right\}.$$

Provided the slope of the smoothed curve is nowhere too great, the smoothed data u_1 . . . u_n as read off from the machine correspond to the values as given by the formula above. The constant k, and accordingly also α and p, can be simply expressed in terms of the physical characteristics of the machine ; thus

$$k = \frac{ab\rho l}{m(b-a)},$$

where a is cross-sectional area of any of the iron rods ; b is internal cross-sectional area of any of the glass tubes ; ρ is density of mercury ; l is distance between two adjacent cylinders ; m is the mass attached to the free end of the string.

It is felt that the machine should find a very wide field of practical application wherever investigators are concerned with the study of trends of statistical data, not only in scientific work but also in the economic and industrial world.

A more detailed description of the machine, together with a discussion of experimental results and of possible modifications in design, will appear elsewhere in due course.

T. SCHUMANN.
(Chief Meteorologist.)

Meteorological Office,
Pretoria.
April 14.

[1] Schumann, *Phil. Mag.*, **26**, 970 (1938).

Splitting of Protein Molecules by Ultra-violet Light and α-Rays

IN a previous communication[1], we have reported on a well-defined splitting of the molecule of *Helix* hæmocyanin by ultra-violet light. The idea that we have to deal with a primary photochemical process was put forward.

If this really is the case, one would expect temperature to have very little effect on the reaction. To test this assumption we have irradiated frozen hæmocyanin solutions at the temperature of liquid air. The reaction took place with practically the same velocity as at room temperature, giving rise to half-molecules.

For purposes of comparison we also studied the action of ultra-violet light on hæmoglobin and serum albumin. The latter reaction has recently been subjected to a very thorough study by a group of American investigators[2]. Irradiation at room temperature and at 0° C. causes the formation of low-molecular substances and also a general inhomogenization of the protein. Our experiments confirmed this result. For hæmoglobin, the ultra-centrifugal test also revealed a very pronounced inhomogenization of the protein, a continuous series of molecules of both lower and higher weight than the normal being formed.

When irradiated at the temperature of liquid air, hæmoglobin showed no change whatever even after an exposure five times as long as that required to give noticeable effect at room temperature. Serum albumin was just slightly affected. It is obvious, therefore, that the effects observed in hæmoglobin and serum albumin, when irradiated at room temperature, are due mainly to secondary reactions.

A more concentrated kind of energy might have a different effect. As a first example of this type we have tried the action of α-rays on *Helix* hæmocyanin, hæmoglobin and serum albumin, both at room temperature and at the temperature of liquid air. Radon was dissolved in a solution of the protein and the sample left to the action of the radiation from Rn, RaA, RaC and RaC′ for different lengths of time. Under these conditions there is added to the effect of α-rays also that of the β- and γ-rays. The ionization due to the latter, however, is only 1–2 per cent of the former and their action is therefore negligible. All the proteins showed qualitatively the same behaviour towards α-rays as towards ultra-violet light. Hæmocyanin was split into half-molecules regardless of temperature, while hæmoglobin and serum albumin were made inhomogeneous when acted upon at room temperature but not at liquid air temperature.

An attempt has been made to calculate the reaction velocity in the case of *Helix* hæmocyanin irradiated by α-rays. The density of the ions along the path of an α-particle is so high that one might assume that every hæmocyanin molecule situated on the path is caused to split into halves. If ν is the average number of hits that a molecule receives, the probability of no hit is $e^{-\nu}$ and, therefore, the relative concentration of unchanged molecules

$$c/c_0 = e^{-\nu}. \quad . \quad . \quad . \quad (1)$$

A consideration of the geometrical conditions shows that in our experiments where a low protein concentration was used (number of molecules per c.c. around 10^{14}) we have as first approximation

$$\nu = \alpha r a, \quad . \quad . \quad . \quad (2)$$

where α is the number of rays per c.c. during the whole period of irradiation, r is the average range in the solution of the α-particles from Rn, RaA, RaC, and RaC′ ($4{\cdot}23 \times 10^{-6}$ cm.) and a the effective cross-section of the hæmocyanin molecule taken as an ellipsoid of rotation (approximately $1{\cdot}81 \times 10^{-11}$ cm.[2]).

A series of experiments with varying number of α-rays per c.c. gave the following figures.

Time of irradiation in days	α	r from equation (2)	c/c_0	
			Experimental determination	Theoretical values from equation (1)
0·6	$0·9 \times 10^{13}$	0·07	0·91	0·93
2·0	1·9 "	0·14	0·85	0·87
4·1	3·3 "	0·26	0·82	0·77
11·6	5·6 "	0·43	0·72	0·65

In view of the approximations made and the experimental difficulties involved, the agreement between the experimentally determined and the calculated relative concentrations of unchanged molecules is quite satisfactory and supports the assumption that every hæmocyanin molecule hit by an α-particle is split. This means that, out of the energy received in any part of the molecule, a portion large enough to cause splitting is transferred to the bond holding the two halves together.

As yet we have not carried out measurements of the absolute number of ultra-violet light quanta active in this splitting, but the independence of temperature points to a quantum yield of unity. It is of interest to note that from studies of the action of various rays on the mutation rate, it has been inferred that the production of a single ion pair within a sensitive spot of the cell, probably the gene, produces mutation[3]. There seems to be a certain analogy between this finding and our results.

The different behaviour of hæmocyanin on one hand and hæmoglobin and serum albumin on the other seems to us to be of considerable importance. It shows that the former molecule is easily dissociated by absorption of energy while the latter ones are very stable against a raising of the energy-levels so long as secondary chemical reactions are excluded.

THE SVEDBERG.
SVEN BROHULT.

Institute of Physical Chemistry,
The University,
Uppsala.
April 28.

[1] Svedberg, T., and Brohult, S., NATURE, 142, 830 (1938).
[2] Sanigar, E. B., Krejci, L. E., and Kraemer, E. O., *Biochem. J.* 33, 1 (1939).
[3] Cf. Stubbe, H., "Genmutation", 327 (Berlin, 1938).

Energy of Neutrons liberated in the Nuclear Fission of Uranium induced by Thermal Neutrons

IT has been shown that *fast* neutrons are liberated in the process of nuclear fission induced in uranium by primary *thermal* neutrons. Two different methods of detection have been used: in the first method[1], the primary and (if any) secondary neutrons are absorbed in a medium in which an endo-energetic reaction can take place, leading to the formation of an easily detectable radioactive nucleus. If the energy threshold is situated above the maximum energy of the primary neutrons, any positive results observed must be ascribed to the secondary neutrons. In the second method[2], elastic collisions of fast neutrons with heavier nuclei are observed by means of an ionization chamber filled with a gas at atmospheric pressure and connected to a linear amplifier. In order to study separately the effect due to the primary thermal neutrons, the experiment is performed with, and without, a cadmium shield between the source and the uranium mass.

The first method having shown us that fast secondary neutrons are produced with energies of at least 2 Mev. (sufficient to transform ^{32}S into radioactive ^{32}P in detectable quantities), we sought to ascertain, by the second method, whether neutrons of energy notably higher than 2 Mev. are also present in the secondary radiation. In our experiment, the oxygen-filled ionization chamber was placed in a nearly cubical box (9 cm. × 9 cm. × 8 cm.) containing uranium oxide and surrounded by a thick layer of paraffin wax. The source (300 mgm. Raγ + Be), surrounded by a lead shield (5 cm. in the direction of the chamber) was buried in the wax. In order to absorb thermal neutrons, the uranium box could be screened on all sides with a cadmium foil. The pulses were recorded either in the presence or in the absence of this foil and the part of the effect (projection of oxygen nuclei by fast neutrons liberated in the uranium) due to thermal neutrons could thus be evaluated.

In view of the large number of of accidental pulses due to the strong γ-radiation emitted by the source, only nuclei recoiling with at least 1·5 Mev. could be taken into consideration. The distribution curve shows that the frequency of pulses observed falls off rapidly between 1·5 Mev. and 2·5 Mev.; between 2·5 Mev. and 3·7 Mev. the frequency decreases much more slowly, pulses observed in this second region being, however, very rare. The total number of pulses recorded is small (with cadmium: 84 pulses in 90 minutes; without cadmium: 161 pulses in 90 minutes); but it appears clearly that recoils with energy of about 2·5 Mev. are notably more frequent in the absence of cadmium and, therefore, that *neutrons possessing an energy of at least* 11 Mev. *are liberated in uranium irradiated with thermal neutrons.*

The high energy of these fast neutrons shows that their parent nuclei are in a highly excited state at the moment of their liberation, which is probably simultaneous with the fission. In this way a non-negligible fraction of the fission energy is disposed of; a further fraction is carried off by the β- and γ-rays afterwards emitted by the nuclei produced in the fission. The remainder available as kinetic energy for these recoiling nuclei is therefore considerably smaller than the total amount of energy liberated in the fission process (about 200 Mev.).

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[1] Dodé, M., von Halban, jun., H., Joliot, F., and Kowarski, L., *C.R.*, 208, 995 (1939).
[2] Szilard, L., and Zinn, W., *Phys. Rev.*, 55, 799 (1939).

Homometric Structures

IN connexion with a recent discussion[1] of the question of the uniqueness of an X-ray crystal analysis, Prof. Linus Pauling has directed my attention to a curious property of the point position[2] $T_h^7 - Ia3 - 24(d)$. Pauling and Shappell[3] have shown that this point position, which involves a single parameter u, has a structure factor which is even in u, while parameter values $+u$ and $-u$ correspond to the structures which are not identical

nor are they mirror-images of one another. An examination of this point position shows that these structures give identical sets of interatomic distances.

For the sake of brevity, we shall make use of the term 'homometric' to describe the relation between two structures which possess the same interatomic distances. For the present, we shall restrict the use of the term to those structures which give the same X-ray diffraction pattern; that is, for two interatomic distances to be considered the same, they must both be terminated by a similar pair of like or different atoms. It follows immediately that identical structures and structures that are mirror-images of one another are homometric to one another. In the discussion which follows, we generalize the term identical to include those structures which are mirror-images of one another as well as those which are identical in the usual sense.

An examination shows that the special point position $O_h^{10} - Ia3d - 24(f)$ also leads to two non-identical homometric structures for positive and negative values of the single parameter; and it becomes important to discuss the frequency of occurrence of this phenomenon. An examination of the subgroups of T_h^7 and O_h^{10} on the same lattice indicates that there are no homometric pairs of structures, among the special points of one parameter, which can be obtained by a simple change of sign.

No direct method seems to offer itself for the enumeration of the number of possible sets of non-identical homometric structures. For this reason the following brief account of a cursory examination of the problem is presented in the hope that other workers in the field may make further progress. It is obvious that such an enumeration is essential for the complete discussion of the uniqueness of an X-ray crystal analysis, since it is well known that this method can at best determine the interatomic distances.

An examination of the genesis of the homometric property in T_h^7 and O_h^{10} indicates that it is associated in these groups with the trigonal and the cubic symmetry of these groups. This fact is confirmed by the absence of the property among the subgroups of these space groups. An examination of the special points of the cubic, hexagonal and trigonal system, involving one or two parameters, seems to show that there are no non-identical homometric pairs obtained by a simple change of sign.

A few space groups can be directly eliminated by considering the homogeneity of any point position. In any space group which contains an operation of the second kind, the equivalent points fall into two classes. The set of vectors (A) drawn from any point of the first class to all other points in the cell are enantiomorphous with the set of vectors (A') drawn from any point of the second class. An examination of the two known non-identical homometric pairs shows that in going from one structure to the other the following process is carried out. Each of the two sets of interatomic vectors belonging to the first member of the pair can be split into two halves: A_1 and A_2, and A_1' and A_2'. To construct the second member of the pair, we then combine A_1 with A_2', and A_1' with A_2, thus arriving at a different structure with the same interatomic distances. It is obvious that such an operation cannot be performed on a group which does not contain an operation of the second kind, and that the 65 Sohncke groups can therefore be eliminated from consideration. It also seems possible to eliminate those space groups which permit only 2, 4 or 6 equivalent points, since at least 4 points are required to establish the property of enantiomorphism in three dimensions, and it does not seem possible to carry out the operation described above on a set of 6 equivalent points. This results in the elimination of a further 44 space groups, but it has not proved possible to carry this line of argument further.

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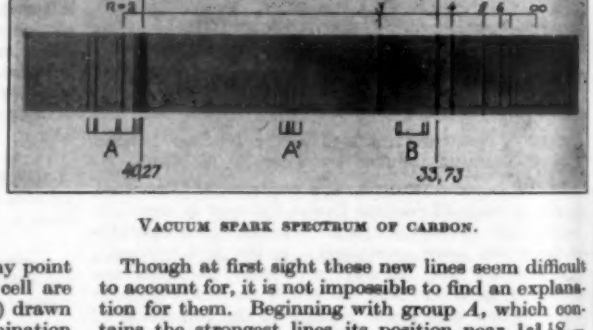
[1] Patterson, A. L., *Phys. Rev.*, **55**, 682 (1939).
[2] cf. "Internationale Tabellen zur Bestimmung von Kristallstrukturen" **1**, 322 (Berlin, etc. 1935); or R. W. G. Wyckoff, "Analytical Expression of the Results of the Theory of Space Groups" 127 (Washington 1930).
[3] Pauling, L., and Shappell, M. D., *Z. Krist.*, **75**, 128 (1930).

Atomic Energy States of an Unusual Type

WHEN examining the vacuum spark spectra of light elements, some rather unexpected lines have been observed, which indicate optical energy states extremely high above the ionization limit, having a character approaching that of X-ray levels.

The observations concern the elements from No. 5 (boron) to No. 9 (fluorine), and extend over the wave-length region from 60 A. to 15 A. The spectrum in this region should be very simple, only consisting of two series of lines $1s\ ^1S - np\ ^1P^\circ$ and $1s^2\ ^1S_0 - 1s\ np\ ^1P_1^\circ$. On well-exposed spectrograms we find, however, besides these normal series and a strong intercombination line $1s^2\ ^1S_0 - 1s\ 2p\ ^3P_1^\circ$, a considerable number of additional lines appearing in distinct groups as shown in the accompanying illustration in which the groups are marked A, A' and B.



VACUUM SPARK SPECTRUM OF CARBON.

Though at first sight these new lines seem difficult to account for, it is not impossible to find an explanation for them. Beginning with group A, which contains the strongest lines, its position near $1s^2\ ^1S_0 - 1s\ 2p\ ^1P_1^\circ$ indicates transitions of essentially the type $1s^2 - 1s\ 2p$. In the first place, one has to consider $1s^2.2s - 1s\ 2p.2s$ and $1s^2.2p - 1s\ 2p.2p$, but as the number of observed lines is greater than can be accounted for in this way, one must also include $1s^2.3s - 1s\ 2p.3s$, $1s^2.3p - 1s\ 2p.3p$ or other similar transitions in a three-electron spectrum, possibly also combinations in a four-electron configuration such as $1s^2.2s^2 - 1s\ 2p.2s^2$. The deep terms in the above three-electron transitions are known from the ordinary Li I-like spectra (C IV, etc.); and the

series limits of the high terms, being normal terms in the He I-like spectra, one can predict the location of higher series members such as $1s^2.2s-1s\,3p.2s$ or $1s^2.2p-1s\,3p.2p$. Confirming the explanation of A, the group A' falls at the position for second series members to lines of group A. The original spectrogram even shows traces of the third group of the same series.

As a consequence of the above explanation, one must assume the existence of discrete energy levels lying *above* the ionization limits by amounts up to *five times* the ionization potential of the same spectrum, in the case of F VII nearly 600 volts above the ionization limit of F VII. A previously known analogy to these terms are those found by Beutler[1] in the absorption spectra of metal vapours, which in certain cases surpassed the ionization limit by almost 17 volts.

The lines of group B, approaching the line $1s\ ^2S-2p\ ^2P^o$ from the long wave-length side, are undoubtedly analogous to the lines in He I found by Compton and Boyce[2] and interpreted by them as transitions of the type $1s.2s-2p.2s$ and $1s.2p-2p.2p$, an explanation which has later been confirmed by several theoretical calculations[3].

We may recall that the X-ray line $K\alpha$ of a free carbon atom may be written as $1s^2.2s^2\,2p-1s\,2p.2s^2\,2p$, being essentially the same transition as the resonance line of C V, $1s^2\ ^1S_0-1s\,2p\ ^1P_1$, at 40·3 A. The presence of additional outer electrons will reduce the field in which the transition takes place, and consequently cause a shift towards longer wave-lengths. The $K\alpha$ of carbon, as observed in various crystal lattices[4], extends with several maxima from 42·5 to 46 A. It is then obvious that the lines of group A with respect to both configuration and wave-length take a place intermediate between a true optical line and the corresponding X-ray line.

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[1] Beutler, H., *Z. Phys.*, **86**, 495 (1933); and eight subsequent papers.
[2] Compton, K. T., and Boyce, J. C., *J. Franklin Inst.*, **205**, 497 (1928).
[3] See for references: Kiang, A. T., Ma, S. T., and Wu, T. Y., *Chinese J. Phys.*, **2**, 117 (1936).
[4] Siegbahn, M., and Magnusson, T., *Z. Phys.*, **98**, 1 (1935).

Aurora and Geomagnetic Disturbance

IN the course of analysis of simultaneous auroral and geomagnetic events at Fort Rae, North West Canada, during the Second International Polar Year, a feature has emerged about which we consider it advisable to make a preliminary report. If the elevation above the horizon of an auroral arc be φ, and if θ be the elevation of a concentrated linear electric current to which the simultaneous vector components $\triangle H$ and $\triangle Z$ in the geomagnetic meridian field may be attributed, then in seventy cases selected solely on the basis of a substantial magnitude of each of $\triangle H$ and $\triangle Z$, θ and φ are on the same side of the magnetic vertical plane five times as frequently as on opposite sides.

This result is significant only because Fort Rae is almost under the zone of maximum auroral frequency, where arcs are formed with equal frequency on either side of the zenith.

In 35 per cent of the selected cases, $\theta-\varphi$ is less than 10°; in 60 per cent within 20°. On occasion, the movement of an arc across the zenith was accompanied by a simultaneous change in the direction of the vertical disturbance vector, indicating a movement of similar sense of the overhead current system responsible for the vector change.

We deduce that, at least in high magnetic latitudes, there is probably a closer spatial association than has hitherto been supposed between the current system which produces the major short-period perturbations in the earth's field and the currents which manifest themselves as auroral arcs at heights mainly between 100 km. and 115 km.

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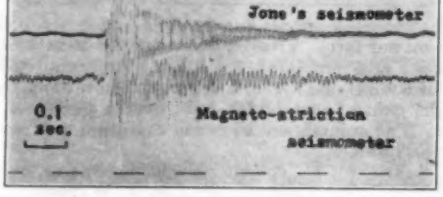
Sensitivity of the Geophone

IN experimenting with a magneto-striction seismometer originally designed for geophysical prospecting, some characteristics of the instrument were observed to be of interest. The geophone, when combined with a suitable amplifier, is capable of yielding a very high sensitivity, yet by itself it is so strong that it can be handled without a clamp just like a piece of metal, and it appears to be a most suitable instrument to study the effect of bomb explosions on buildings, steel structures and shelters. Actually it can be built into the steel structure and placed almost on the site of an explosion.

The geophone consists of a coil and a magnetized nickel rod carrying a weight. Working in combination with an amplifier, consisting of 4 D.C. valves coupled with resistances, and an improved Shire's oscillograph[1], the sensitivity of the instrument is of the same order as Jone's seismometer[2], one of the most sensitive portable instruments existing.



The accompanying plate is a record of these two types of seismometers placed side by side recording the same 'earthquake', which was produced by the dropping of a 20 gm. mass from a height of one metre on to a carpet-covered concrete floor about 20 ft. away from the instruments. Being an accelerometer, the new instrument shows a much sharper onset in its record. The natural frequency of the magneto-striction instrument is extremely high. Its oscillation is damped down by internal friction so rapidly that it is not detectable by the camera. In another model, a mechanical lever has been used which increases the sensitivity 30–50 times further.

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[1] *J. Sci. Inst.*, **11**, 379 (1934).
[2] *J. Sci. Inst.*, **9**, 8 (1932).

Digestibility of Straw

STRAW contains large quantities of carbohydrates, which can only be partially digested by farm animals. Various attempts have been made in the past to increase the digestibility of straw by some pre-treatment.

In Great Britain, Godden[1] carried out some preliminary work with soda in 1920, and states that "There is obviously need for much further investigation of the possibilities of soda treatment before a final opinion can be expressed as to its merit for introduction into farm practice".

In the course of a wide investigation of the problem, we have treated oat- and wheat-straws with caustic soda solutions of varying strengths and for different lengths of time.

Our best results were obtained with a concentration of soda of the order of 1·25 per cent with an immersion period of 20–24 hours without any heating. With the volume of solution used, this represented 10 lb. of caustic soda per 100 lb. of straw. Weaker solutions were not so effective, even if the time of immersion were increased. Of the 10 lb. of caustic soda there is a recovery of 40–50 per cent, which can be made up to the correct level for subsequent batches.

The treated straw is easily washed with water, and is then readily eaten by ruminants.

The process seems to depend upon the breaking down of the lignin-cellulose complex to such an extent as to allow of more complete utilization of the material in the paunch than is possible with the untreated straw.

The effect of treatment is shown by the following preliminary figures for the starch equivalent values of treated and untreated straw, calculated from the digestibility data obtained in metabolism experiments with sheep.

	Lb. starch equivalent per 100 lb. straw	
	Treated	Untreated
Oat straw	42·1	21·7
Wheat straw	32·0	13·0

The process is simple in operation, and is now being used on our farm. Treated oat straw fed to fattening bullocks and supplying 7·4 lb. of starch equivalent out of a total of 11·8 lb. has resulted in a daily live-weight gain of just under 2 lb. over a period of 62 days. The animals are in prime condition and ready for the butcher.

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[1] Godden, W., *J. Agric. Sci.*, **10**, 437 (1920).

Importance of Cytochrome *B* in Hydrogen Transport

IT is quite definitely known[1] that dihydrococymase can be oxidized by molecular oxygen in the presence of diaphorase I plus the 'cytochrome system', but the nature of the cytochrome reaction has not been clearly demonstrated. On the basis of the experiments reported here, we believe that both cytochrome *B* and cytochrome *C* are required for the oxidation of both CoH_2I and succinate.

Using spectrophotometric technique, we have shown that the rate of oxidation of 60 γ of CoH_2I by a preparation poor in cytochrome *C* was doubled when 4×10^{-9} mols of pure cytochrome *C* were added. By measuring the rate of cytochrome *C* reduction in the presence of sufficient cyanide (10^{-4} mols per ml.) to block completely the action of cytochrome *C* oxidase, it was possible to show that CoH_2I would reduce cytochrome *C* rapidly in the case of a fresh enzyme preparation, and not at all or only slowly in the case of an acid-precipitated dried enzyme used in amounts which contained the same quantity of diaphorase I (as shown by the CoH_2I plus methylene blue reaction).

That the missing compound in the dried preparation might be cytochrome *B* was indicated, among other things, by the fact that the reduction of cytochrome *C* by CoH_2I in the presence of the fresh preparation is prevented by strong cyanide (10^{-4} mols per ml.). This is also the case when succinate is the hydrogen donator, and can be demonstrated spectroscopically or visually, using 10^{-7} mols of cytochrome *C* as the final reduced product. The degree of cyanide toxicity is undoubtedly affected by the enzyme concentration. The fresh enzyme mentioned above contained 3·5 mgm. per ml.

It seems possible that the missing component in the succinoxidase system described by Hopkins, Lutwak-Mann and Morgan[2] may include cytochrome *B*. Details and implications of our experiments will be reported later.

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[1] Potter, NATURE, **143**, 475 (1939), and references.
[2] Hopkins, Lutwak-Mann and Morgan, NATURE, **143**, 556 (1939).

Temperature Activation of the Urease-Urea System

THE activity of several enzymes (for example yeast and malt invertase[1], and *E. coli* dehydrogenases[2]) has been shown to increase exponentially with temperature according to the Arrhenius equation,

$$K = Ze^{-\mu/RT},$$

where K is the rate, Z is a constant, e is 2·718, R is the gas constant, T the absolute temperature, and μ the energy of activation of the reaction in calories per gm. mol.

Heretofore, no comparison has been made of temperature activation of an impure and a highly purified enzyme. A study was made of the hydrolysis of 1·5 per cent urea in phosphate buffer at *p*H 7·0 using both crude and crystalline Jack bean urease[3]. The reaction was followed by measuring ammonia formation colorimetrically after Nesslerization, or carbon dioxide evolution volumetrically using the Barcroft differential manometer. For either crude or crystalline urease the rate of urea hydrolysis increases with temperature in accordance with the Arrhenius equation, where μ = 8,700 or 11,700 cal. over the whole temperature range up to the inactivation temperature, or μ = 11,700 below and 8,700 above a critical temperature of about 22° C. When urease is dissolved in water or in reducing or indifferent solutions, μ = 8,700, but when dissolved in oxidizing solutions, μ = 11,700. The activation energy seems

to depend upon the oxidation-reduction potential of the digest. When the potential was adjusted with varying proportions of ferri- and ferrocyanide it was apparent that with an E_h above + 0·46 v., μ = 11,700, below + 0·42 v., μ = 8,700, and between + 0·42 and + 0·46 v., μ = 11,700 below and 8,700 above the critical temperature.

It is suggested that the energy of activation of the urease-urea system is determined in part by the configuration of certain essential radicals such as the sulphydryl[4] groups in the enzyme molecule. When such structures are in the reduced condition, μ = 8,700, but when oxidized, μ = 11,700. The change from the reduced to the oxidized form is reversible and is accompanied by this shift in temperature characteristic.

The temperature characteristic of 20,800 for soy bean urease is listed in most text-books. This value was calculated by Euler[5] from the data of Van Slyke and Cullen[6] and is incorrect. Recalculations indicate a value for μ of 11,700; this is identical with one of those obtained with Jack bean urease. It is apparent that the activation energy is independent of the source and purity of the urease, but does shift in a predictable manner with the oxidation-reduction potential of the digest.

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[1] Sizer, I. W., *J. Cell. and Comp. Physiol.*, **10**, 79 (1937); *Enzymologia*, **4**, 215 (1938).
[2] Gould, B. S., and Sizer, I. W., *J. Biol. Chem.*, **124**, 269 (1938).
[3] Sumner, J. B., *J. Biol. Chem.*, **69**, 435 (1926).
[4] Hellerman, L., Perkins, M., and Clark, W. M., *Proc. Nat. Acad. Sci.*, **19**, 855 (1933).
[5] Euler, H., "Chemie der Enzyme", Teil 1 (1920).
[6] Van Slyke, D. D., and Cullen, G. E., *J. Biol. Chem.*, **19**, 141 (1914).

Vitamin C Sources in Eskimo Food

IT is the general experience among arctic explorers that when they 'live of the land', scurvy never occurs. Stefansson[1], who directed attention to this fact, cured three cases of scurvy with reindeer meat.

A Norwegian scientific expedition to Angmagssalik was made during 1936–37 for the purpose of examining nutrition, metabolism, physique and health of Eskimos. The accompanying table shows the vitamin C content of the available food. The numbers are means of at least two observations. We used the method of Emmerie and van Eekelen[2].

It must also be mentioned that 'mattaq' (epidermis of whale) which Bertelsen[3] especially has pointed out as a good antiscorbutic remedy, contained 20 mgm. ascorbic acid per 100 gm. (from narwhal). In skin of young seals from the coast of Norway we found such enormous amounts as 180 mgm. per 100 gm.

It is well known that marine algæ are used as food in Japan, China, Hawaii, and some algæ are eaten on Iceland and on the coast of certain parts of Great Britain. The Eskimos eat them raw or dipped in boiling water (or broth) or with blubber oil. From this source, the Angmagssalik Eskimo get 50 per cent of their vitamin C.

The other 50 per cent is mainly obtained from organs of mammals and birds and also from fish. On an exclusive lean meat diet one gets about 25 mgm. vitamin C a day, even when the meat is boiled. By boiling, 50 per cent is extracted or oxidized. If the broth also is used, one gets nearly 40 mgm. a day. This agrees with the experiences of Stefansson[1].

VITAMIN C (*l*-ASCORBIC ACID) IN COMMON ESKIMO FOODS

(Mgm. per 100 gm.)

FJORD SEAL (*Ph. fœtida*)		GUILLEMOT (*Uria grylle*)	
Adrenals	127	Liver	22
Thymus	26	Brain	16
Liver	18	Eye	9
Central nervous system	18	Intestine	5
Epididymis	17		
Kidney	13	EIDERDUCK (*Somateria mollissima*)	
Eye	10	Liver	17
Lymph gland	7	Eye	14
Pancreas	7	Brain	9
Ovary	7	Intestine	4
Skin	3		
Small intestine	3	INVERTEBRATES	
Blood	3	Sea mussel (*Mytilus edulis*)	6
Meat	2	Crayfish sp.	3
Heart	2		
Blubber	0	COD (*Gadus callarias*)	
Other organs (average)	1	Liver	8
		Meat	2
PLANTS		Roe	44
Rosewort (*Sedum roseum*)	27	Cod liver oil	0
Mountain willow (*Salix* sp.)	18		
Dandelion, leaves (*Taraxacum officinale*)	15	MARINE PLANTS	
Angelica (*Archangelica officinalis*)	14	*Alaria* sp.	45
Crakeberries (*Empetrum hermafrodit.*)	9	*Rhodymenia palm.*	17
		Fucus sp.	13
		Ascophyllum nod.	11

In the opinion of one of the authors (A. H.), who has been on sledging journeys of long duration in the Arctic, less than 15 mgm. ascorbic acid a day effectively prevents scurvy.

The Angmagssalik Eskimo get a daily average dose of about 40 mgm. per adult. In agreement with this finding, scurvy is unknown among Angmagssalik Eskimos.

A detailed report on the results of the work of the expedition will appear in a book this autumn.

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[1] Stefansson, "Observations on Three Cases of Scurvy", *J. Amer. Med. Assoc.*, **71**, 1715–1718 (1918).
[2] Emmerie, A., and van Eekelen, M., "Some Critical Remarks on the Determination of Ascorbic Acid", *Biochem. J.*, **30**, 25–27 (1936).
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Hormone from the Human Corpus Luteum of Early Pregnancy

THE human corpus luteum of pregnancy is cystic up to the fourth month of pregnancy. The fluid content of the luteal follicle may be as much as 1·5 c.c.

The action of single doses of the luteal fluid (0·5–1·0 c.c.) is different from progesterone ('Proluton', Schering).

The luteal fluid causes deturgescence to supervene in three stages whereas progesterone produces a sudden type of deturgescence; perineal rest is attained twelve days after the injection of luteal fluid whereas with progesterone the perineum returns to rest in five and not later than seven days; the perineal rest induced by luteal fluid lasts 10–11 days, but in the case of progesterone perineal rest is transitory and is over in twelve hours; the effects of luteal fluid are maintained for 20–21 days whereas progesterone does not act longer than seven days.

Progesterone in doses greater than 3 mgm. and less than 20 mgm. prolongs the cycle by 3–9 days whereas the luteal fluid shortens the cycle by 6–8 days.

In virgin rabbits, 0·1 c.c. of the luteal fluid administered intravenously leads within 48 hours to gross enlargement of the uterus (five times the normal), great enlargement of the follicles on the ovary some of which may contain blood, and a great increase in the interstitial cells.

An ether extract of the luteal fluid equivalent to 0·05 c.c. of luteal fluid injected intravenously into a virgin rabbit causes a great increase in the interstitial tissue of the ovary without any effect on the follicles, and the uterus is enlarged to three times its normal size. The fluid not soluble in ether leads to cystic change in the follicles of the rabbit's ovaries, scarcely any action on the interstitial cells, and the uterus is only slightly increased in size.

Progesterone represents probably only a part of the luteal hormonal complex, its chief action in the baboon being that of causing vascular alterations in the uterine stroma and the perineum after these organs have been sensitized by œstrone. In the rabbit, progesterone causes progestational changes in the previously œstrone-sensitized uterus. The luteal fluid not only affects the uterus and perineum in the baboon but also the ovaries and perhaps even the pituitary. In rabbits both the ovaries and uterus are profoundly affected.

For these several reasons, we are of the opinion that the luteal fluid of the corpus luteum of early pregnancy contains one or more hormones which have not been identified hitherto, and which we suspect to be the true hormone or hormones of the human corpus luteum of early pregnancy.

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Points from Foregoing Letters

A MECHANICAL device for eliminating the computations involved in obtaining a smooth curve, from a set of data such as the annual distribution of rainfall, is described by T. Schumann. The device consists essentially of a vertical wooden board to which are attached movable glass cylinders filled with mercury in which iron rods are floating. The author gives the theory underlying the mechanical process involved and suggests that the device may be useful in dealing with economic and industrial data.

The Svedberg and Sven Brohult state that irradiation of hæmocyanin, hæmoglobin and serum albumin with ultra-violet light and α-rays, both at room temperature and at the temperature of liquid air, has shown that in the case of hæmocyanin the effect (splitting into half-molecules) is a primary reaction while in the case of the two latter proteins the (rather irregular) breakdown is mainly caused by secondary reactions. The amount of hæmocyanin dissociated by a certain number of α-particles can be accounted for upon the assumption that each molecule struck by an α-ray is split into halves.

H. von Halban, jun., F. Joliot and L. Kowarski show that secondary neutrons liberated in uranium irradiated with thermal neutrons can communicate to oxygen nuclei, in an oxygen-filled ionization chamber, a recoil energy of about 2·5 Mev.; the secondary radiation must, therefore, contain neutrons possessing an energy of at least 11 Mev.

In connexion with 'homometric' structures (which give the same X-ray diffraction pattern), A. L. Patterson discusses two point positions each of which leads to two non-identical homometric structures for positive and negative values of a single parameter. He inquires into the genesis of the homometric property, which appears to be associated in these cases with the trigonal and the cubic symmetry of the groups.

In the vacuum spark spectra of light elements certain groups of lines have been observed by B. Edlén and F. Tyrén which do not fit in the ordinary series spectra, but indicate atomic energy states of an unusual type very high above the ionization limit of the corresponding ion, approaching in their character X-ray levels.

J. M. Stagg and J. Paton consider that near the zone of maximum auroral frequency the electric current systems responsible for surface geomagnetic disturbance and those manifested as auroral arcs may be more closely associated spatially than hitherto supposed.

That the effect of bombs and explosions upon buildings and shelters can be suitably studied by means of the 'geophone' (a seismometer consisting of a coil and a magnetized nickel rod carrying a weight) is suggested by Weng Wen-Po.

R. E. Slade, S. J. Watson and W. S. Ferguson find that by treatment with cold dilute caustic soda solution the feeding value of oat straw can be increased by 100 per cent and that of wheat straw by 150 per cent. The digestibility of the product has been determined by experiments on sheep, and bullocks have been fattened for the market with the treated straw.

V. R. Potter and E. E. Lockhart suggest that both cytochrome *B* and cytochrome *C* are required as intermediate carriers for the oxidation of dihydrocozymase and succinate by molecular oxygen and the appropriate enzymes.

I. W. Sizer states that the activation energy of the urease-urea system is independent of the enzyme purity when crude Jack bean meal was compared with the crystalline enzyme prepared from this source. The activation energy is determined by the oxidation-reduction potential of the digest.

It is pointed out by A. Høygaard and H. W. Rasmussen that arctic primitive foods are good sources for vitamin C and a table is given showing the vitamin C content of the most common Eskimo foods. On average diet the Angmagssalik Eskimo daily gets 40 mgm. ascorbic acid per adult. 20 mgm. is obtained from eating marine algæ. Scurvy is unknown among Angmagssalik Eskimos.

The presence in the human corpus luteum of early pregnancy of one or more hormones distinct from progesterone is indicated, according to J. Gillman and G. Spence Smyth, by the distinctive action of the luteal fluid upon the uterus and the perineum.

Research Items

Prehistoric Pottery in Southern Africa

THE material from the excavation of the Mumbwa Cave, Northern Rhodesia, considered essential for the elucidation of the prehistory of South Africa, with the exception of part of the collection associated with the deeper burials, and the human skeletal remains, was destroyed by fire in the Ethnological Museum of the University of Witwatersrand. The excavators, Prof. Raymond Dart and N. del Grande, recorded in 1931 that pottery occurred in all the levels, though only sparingly in the deeper, down to the very base of the Late Stone Age deposits at a depth of two metres. It is the fragments from these deeper levels which survive, and have now been described and discussed further by L. W. Wells (*Man* of May, 1939). Not only do these fragments show that the pottery of the deeper levels was homogeneous, but also comparison with photographs of the pottery of the higher levels indicates an identity of characteristics and strong evidence for community of types between all levels. This agrees with the homogeneity of the lithic culture, and the continuity of the associated skeletal remains. The Mumbwa pottery holds an isolated position among African ceramics. It is of a type which, if found unassociated, would have been classified as Bantu; but as it is associated with a well-characterized lithic and human skeletal remains of predominantly Bush-Boskopoid character, devoid of recognizable Negro feature, it must be regarded as an integral part of a stone age culture, and the work of a non-Negro, pre-Bantu people—a conclusion of the highest importance, as hitherto it has been presumed that all unglazed pottery was of Bantu origin.

Desensitization through Histamine

L. FARMER (*J. Immunol.*, **36**, 37; 1939) finds that the uterine strips of serum-sensitized guinea pigs which had been given injections of histamine at the height of sensitization were less sensitive to the specific antigen than were the sensitized uterine strips of control animals, while the uterine strips of normal guinea pigs which had received injections of histamine were less sensitive to histamine than were the uterine strips of the untreated controls. These experiments suggest (1) that histamine was the substance responsible for the anaphylactic contraction of plain muscle; (2) that it was possible to desensitize sensitized guinea pigs non-specifically by injection of histamine. In conclusion, Farmer points out that the phenomena observed were a further indirect proof of the correctness of Dale's theory of the anaphylactic mechanism, and that they also furnish a basis for understanding the mechanism of the non-specific desensitization by histamine.

Adrenals and Salt Intake

C. P. RICHTER (*Endocrinology*, **24**, 367; 1939) has found that the salt taste threshold of twenty normal rats averaged 0·055 per cent, that is, the animals detected salt in solutions of approximately 1 part of salt to 2,000 parts of water. Removal of the adrenals in eight rats greatly reduced the salt taste threshold. It averaged 0·003 per cent; in other words, the animals distinguished between water and salt solution in a concentration of 1 : 33,000. The adrenalectomized rats showed a craving for salt offered in amounts which could not possibly have had a beneficial effect. The results show that adrenalectomized rats ingest more salt, not because they learn that salt relieves their deficiency discomforts, but because of chemical changes in the taste mechanisms in the oral cavity, giving rise to an enhanced salt discrimination.

Reproduction of 'Immature' Salmon

RECENT researches have directed attention to the occurrence of occasional examples of salmon parr which develop ripe gonads in fresh water without having made that descent to the sea which has generally been considered a prerequisite to reproduction. The observation is no new one; Rondelet, and after him Gesner, discussed it in the sixteenth century, and in 1686 the British naturalist Willughby came very near the mark in stating that while the male parr could fertilize the eggs of adult salmon, the female parr never had ripe eggs. Dr. V. Tchernavin has brought together references to papers dealing with the subject (61 in all) and very briefly summarizes the main results (*Proc. Roy. Physical Soc. Edinb.*, **23**, 73; 1939). Both male and female parrs before descending to the sea may produce ripe germ cells, but the occurrence is much rarer in the female and at a more advanced age. Such male parrs take part in spawning with females which have already returned from the sea journey, and they have been known to spawn twice before leaving fresh water. Moreover, males and females of migratory salmon retained in fresh water develop functional gonads and produce progeny which in their turn are fertile.

Distinguishing Races of *Drosophila pseudo-obscura*

RACE *A* and Race *B* of *Drosophila pseudo-obscura* produce sterile male hybrids when crossed. They react differently to different ecological habitats and are differentiated by many of the criteria used for species differentiation. Nevertheless they are remarkably similar in morphological appearance and can only be separated easily by examination of their salivary gland chromosomes. K. Mather and T. Dobzhansky (*Amer. Nat.*, **73**, 5; 1939) have shown by statistical analysis that the two races may be distinguished by the number of teeth on the sex combs of the males. Race *A* males have a mean number of teeth of 6·46 and 5·32 teeth on the proximal and distal sex combs respectively, whereas race *B* have 5·55 and 4·72 respectively. These are shown to be significantly different and the difference is shown to persist under different environments. The authors show that mathematical treatment is necessary to distinguish race *A* from race *B* by external characters.

Wood Wasps and their Parasites

H. S. HANSON has recently published an interesting article on this subject (*Bull. Entomol. Res.*, April, 1939). As a member of the staff of the Imperial

Institute of Entomology, he has been engaged on a study of these insects in connexion with a request for parasites of the wood wasp, *Sirex noctilio*, which was rapidly increasing in the coniferous forests of New Zealand. The accidental entry of the *Sirex* into the last-named country has led to a major problem in forestry, and the most feasible method of control seems to be by means of the introduction of certain parasites. Of the latter the most important is the large ichneumon *Rhyssa persuasoria*, while second in value is the cynipid *Ibalia leucopoides*. Under normal forest conditions, *Sirex* has never been known to become a pest in Britain owing to the control exercised by parasites. While *Rhyssa* is the superior insect as a parasite, *Ibalia* has also received much attention. The combined attacks by both species of parasite result in a higher percentage of host mortality than when either species is acting alone. *Rhyssa* is now established in New Zealand, but no attempt has so far been made to establish the *Ibalia*, which presents certain features making it more difficult to achieve. The method of biological control may be reasonably expected eventually to prove effective and give the desired results. It needs, however, to be carried out on an adequate scale over a period of years. As compared with sylvicultural methods of control it is vastly cheaper, and probably, in the long run, of greater value.

Blister Rust of White Pine in America

MANY years ago the European black currant (*Ribes nigrum*, L) was introduced into the United States; but now it has been declared a public nuisance, and its cultivation prohibited by statute over a wide area. The reason for this (described in Leaflet 175 U.S. Dept. Agric.) is that the currant and gooseberry, especially the cultivated forms, serve as the alternate host for *Cronartium ribicola* Fischer, which causes blister rust disease of white pine. The fungus is perennial on the pine, living in the bark and wood of infected trees. In the spring spores are produced, which can be carried long distances by the wind, and after a period of growth on the currant or gooseberry, the life-cycle is completed and another type of spore capable of infecting the pine is produced. The disease is a serious menace in white pine plantations, and it attacks trees of all sizes, though resistance seems to increase with age. The pine is of great economic importance, being valued for scenic, recreational, soil retention and watershed purposes. Fortunately there is little demand for black currants on the fruit market, and the excellent progress made in the control of blister rust in those areas where these shrubs have been removed, bears out the wisdom of the new legislation.

Sterility in the Gage and Dessert Plums

IT is generally considered that the gages and several varieties of dessert plums are inherently poor croppers and commercially unprofitable. Consequently little attempt has been made to grow them on a large scale. The recent work of M. B. Crane and A. G. Brown, however (*J. Pom. and Hort. Sci.*, **17**, 51; 1939), has shown that the greengages and the majority of dessert plums have the capacity to crop heavily if they are effectively pollinated. Complete self-incompatibility is common among these varieties, whilst many are only partially self-compatible. Bryanston Gage, Coe's Golden Drop and Transparent Gage are among those which fail completely to set fruit with their own pollen. Some kinds, however, such as Laxton's Gage and Early Transparent Gage, are self-compatible and also act as effective pollinators for other varieties. Among the wholly and partially self-incompatible varieties, cross incompatibility occurs, both complete and in degree. Sometimes it is reciprocal, but it may occur in one direction of crossing only, the reciprocal pollination yielding a full crop of fruit. For successful cropping, suitable varieties should be planted together to ensure effective pollination. Varieties in the same incompatible group and varieties whose flowering times do not coincide or overlap appreciably should not be planted together. The authors have provided data in this respect for an exhaustive list of gages and dessert plums.

Geological Terminology

THE attention of geologists is directed to a most valuable "Lexicon of Geologic Names of the United States" compiled by M. Grace Wilmarth, which has just been published by the United States Geological Survey as *Bulletin* **896** (Part 1, *A–L*, pp. 1–1244; Part 2, *M–Z*, pp. 1245–2396). The definitions state briefly the lithology, thickness, age, underlying and overlying formations, and type locality, together with references. Most names have only one entry, which is essentially a digest of the original definition, as in most cases the original definitions are those still in current use. Some names have several entries, corresponding to redefinitions that have been suggested from time to time, while a few have had a long and interesting history, necessitating brief mention of the views of the geologists who have contributed towards present usage. Where there is disagreement as to definition or age the divergent views are fairly summarized. The time terms have also been listed, but the full definitions of the era, system and series terms having been already given in *Bulletin* 769 (1925), only brief definitions of these are given in the "Lexicon", with references to the earlier publication. The stratigraphical papers on which the "Lexicon" is based are those up to the end of 1935, together with some published in 1936. The compiler's hope that these volumes will "prove a time saver for the busy geologist" is certain to be realized—and not only in the United States.

Low Gas Pressure Measurement

MANY of the devices for measuring low gas pressures depend for their calibration on comparison with a McLeod gauge, and any improvement in the accuracy of this gauge is a distinct gain. Dr. Paul Rosenberg, of Columbia University, New York, has with assistance from the Adams Fund for Physical Research, succeeded in increasing the accuracy of the gauge considerably (*Rev. Sci. Instruments*, April 1939). The principal improvements he introduces are: the roughening of the bores of the capillary tubes, the sealing of the closed capillary in such a way that the outside of it remains cylindrical above where the bore terminates, the more accurate estimation of the change of volume of the bore due to sealing, bringing the mercury in the open capillary up to the level of the end of the closed one for reading, and the support of the mercury bulbs by plaster casts to avoid stresses in the glass. At pressures of 10^{-2}, 10^{-3}, 10^{-4} and 10^{-5} mm. of mercury he claims accuracies of 0·2, 0·6, 2 and 6 per cent respectively, and points out that these are higher than those of the absolute micromanometer at pressures below 5×10^{-3} mm. and of the Knudsen absolute manometer above 10^{-4} mm.

Science and Social Problems

THE first meeting in London of the British Association's new Division for the Social and International Relations of Science was held in the Royal Institution on May 25. Sir Richard Gregory presided and in his introductory remarks sketched the genesis and adumbrated the programme of the new movement. Co-operative work in the special sciences was carried out for sixteen years by the International Association of Academies, and then by the International Council of Scientific Unions, which was formed during the Great War and is still active. Two years ago, on the initiative of the Royal Academy of Amsterdam, an entirely new outlook was adopted by including within the scope of the Council the social significance of the applications of science, thus endorsing the conviction of many that scientific workers can no longer remain indifferent to the social consequences of their discoveries. No definite programme of work has yet been formulated, but the essential idea is to apply the scientific method of inquiry to problems arising from the interactions of natural science and society. The British Association, acting in co-operation with its sister association in America, and through its new Division, is well adapted to promote such inquiries, and with this object in view it is arranging to hold meetings not only at the time of the annual meeting of the Association but also at other times and places as occasion may arise.

Dr. Ernest Barker, professor of political science in the University of Cambridge, then gave an address on "The Impacts of Science on Society". Natural science acts on society in two main ways: first, by developing a special science, or a body of social sciences, explaining society as a natural phenomenon, and thereby helping it to control itself consciously; and secondly, by producing discoveries and inventions which indirectly affect social behaviour and the general structure and functioning of society. The first way is mainly that of the biological sciences. To-day we do not see society as an engineering contrivance based solely upon matter and motion, but as something organic and vital, which evolves, and whose parts are permeated with interflowing dependence. This view has not only profoundly influenced the study of history, the study of law, and the criticism and understanding of art, but also it has altered our outlook on society itself. A society that interprets itself in biological terms behaves differently in virtue of that new interpretation; the difference may work for evil as well as for good—for example, in the direction of a perverted nationalism,—but the application of general biology to human society is not condemned by the possibility, or the fact, of misapplications.

The second way of action is one both of physical and chemical science and of biology. Physics and chemistry have revolutionized the methods and pace of communication, both material and mental; they have revolutionized industrial production and the art of war. The changes thus brought about are greater than the changes due to political causes. Should science attempt to control the changes which it causes? In Prof. Barker's view, science must proceed with the single regard of discovering truth; if progress were stopped, an evil might be averted but a greater good might be missed; the utmost concession is a slowing down of the impact. It is the business of society, through its leaders, to control the effects, and the one duty of the man of science is to contribute the resources of his own training and technique to the making of a proper and exact estimate of the nature of the changes and of the nature of the relevant remedies.

Biology differs from physics and chemistry in its influence on society, in that its discoveries can be applied most directly, most intentionally and most fruitfully, through the soil and through plants and animals, to the relief of man's estate. The discoveries of genetics and eugenics can improve the strains of plants and animals and the human breed itself. But the improvements arrive very slowly owing to the impedimenta offered by human nature: "sentiments that teem with embarrassing anachronisms, of which we are usually unconscious", embedded habits, traditions, instincts and emotions. Therefore the conscious application of science to the improvement of life will always be a slow-motion picture; the delay, however, may enable science to become sure of its discoveries before they are applied, and thus produce a greater security both of scientific and of human progress.

Sir Daniel Hall, unlike the previous speaker, discussed a concrete theme: "How the application of science to agriculture is impeded". It is necessary, he said, to distinguish between peasant farming, which is virtually self-contained and independent of world markets, and agriculture regarded as an industry, which can look to science for increasing, improving and cheapening its production. There is much peasant farming still in England, where 61 per cent of holdings belong to the 1–50 acre class, and upon which there is relatively little scope for scientific improvements. On farms of all types and sizes there is an average of one master to four or five workers, so that even the larger units of production are very small compared with the units of great urban industries. This fact, together with its consequences, lack of prospects for educated youths without capital, discontinuity of effort, and lack of capital, restricts the application of scientific developments. The importance of time-lag between preparation and production is sometimes exaggerated, but the handicap may be very serious when falling prices intervene. A greater handicap is that of variable weather, which may necessitate waiting for five years or more before the costs of production of a crop can be determined.

The adoption of inventions in machinery is limited by the small size of the farming units; the use of combine harvesters and crop driers is out of the question on most English farms. Equally impracticable are many large works of land improvement and organization, which affect areas beyond the ownership of a single proprietor, but which science indicates would be practicable on a large scale and a long view. The retail structure of agriculture also precludes the exploration of scientific discoveries and inventions, because there are no great agricultural producers to act as intermediaries in translating a laboratory into a large-scale process.

Basic research is outside the farmer's scope, but he can put into practice some of the findings of research organizations; for example, those relating to the effects of fertilizers, improved yields of new varieties or stock, and disease treatment. State intervention is needed in many fields to secure the prosecution of research for the benefit of agriculture, and to make known its results. If increased and cheapened production is regarded as a necessity in the modern State, intervention of another kind is needed to free agriculture from some of the limitations imposed by its present structure; failing that, there is danger that the factory will replace the farm in the production of essential commodities.

The meeting was very well attended, and at the close Prof. A. Ferguson referred to possible research work that might be undertaken by the Division, such as a study of the development of nationalistic feeling, and the history of Western thought. Such interesting and important studies would be welcomed by many, but it may be suggested that they should not take precedence over the essential task of attacking concrete problems in a scientific way. Sir Daniel Hall's remarks on the necessity for State intervention in agriculture suggest that a suitable study would be the very old, but still very important, question of land tenure, of public control of the land and its utilisation. Such a study, it might be objected, would inevitably lead to 'impact', that is, collision, with politics, but it need not be treated in a politico-controversial way. What is needed are the reasoned judgments of trained scientific workers, who have no economic, political, social or other axes to grind, who are capable of submerging the embedded sentiments, of which Prof. Barker spoke (except that of justice), and above all, who will take the vow of placing the common good above all the lesser loyalties, like political party, social class, and the 'old school tie'.

E. H. T.

Hydrogenation

DURING May 24–26, a conference was held in Paris under the auspices of the five chemical societies which share the amenities of the Maison de la Chimie there. The selected subject was the various aspects of hydrogenation. This is the second occasion on which the same five societies have co-operated. An average attendance of more than three hundred was attracted. The meetings commenced at 4.30 in the afternoon, so enabling the participants to go about their ordinary affairs during the working day. The chief figure at the meeting was Prof. Sabatier of Toulouse, still hale and hearty at eighty-four years of age: his original researches are recognized as having given the first impetus to the study of all subsequent hydrogenation reactions, some of which are technically in the forefront of world interest to-day. The presidents of four of the societies presided in turn over the sittings.

The conference appropriately began with a paper from Sabatier, largely of an historical nature, relating to the addition of hydrogen to unsaturated compounds in presence of nickel. Prof. Paul followed with an account of the Raney nickel catalyst. The evening discourse delivered by Prof. Aubel, of Paris, dealt with the general phenomenon of hydrogenation in biology. On the next afternoon, Prof. N. V. Ipatieff, who now holds a chair at the Northwestern University of Chicago, spoke on the use and advantages of copper and copper chromium catalysts for the hydrogenation of benzene and its derivatives, describing work which is being followed with considerable interest. The following paper was delivered by Dr. E. F. Armstrong, who dealt fully with the technical and industrial development of hydrogenation, first in regard to fat hardening, which has now largely become standard practice; afterwards he indicated the methods of manufacture of hydrogen and the approximate cost of this gas, describing also the line of attack which is being followed in the conversion of water gas into petroleum hydrocarbons, and of coal, under pressure, into methane.

At the conclusion of the meeting, Messrs. Ipatieff and Armstrong were each presented with a Chevreul Medal in recognition of their labours in their respective fields of inquiry. The meeting ended with a banquet held in one of the large lecture rooms of the Maison de la Chimie, which readily lent itself to this conversion and was provided with the necessary auxiliary accommodation behind the scenes. The excellent facilities provided here for our French colleagues are the cause of renewed admiration and envy on every occasion we avail ourselves of them. They enabled a first-class banquet with wines to be staged for the modest charge of 60 francs.

The third day was primarily concerned with the official celebration of the twenty-fifth birthday of the Société de Chimie Biologique, but even here the role of active hydrogen was not overlooked, being made the subject of a paper by Prof. Thunberg of Lund.

Work of the Cornish Engineers

IN the form of a reprint from the *Journal of the Royal Institution of Cornwall*, there has been published at the Royal Printeries, Truro, a paper by W. Tregoning Hooper entitled "The World's Debt to Cornish Engineers", one of the aims of which is to commemorate the historic experimental trials of the Austen's 80 in. Cornish pumping engine. At these trials, this engine established a record of accomplishment which demonstrated to men of science, engineers and economists the great potentialities of the power of steam, and the occasion is, therefore, a fitting one to be recalled and celebrated.

In the year 1835, in collaboration with his chief engineer, West, Joseph Thomas Treffry erected a new 80 in. engine and it was stated to have done a duty of nearly 98 million foot-pounds of work per

bushel of coal (94 pounds). This claim was disbelieved and a special trial was arranged to take place before a number of competent and impartial engineers and pitmen. When it was held on October 22 and 23, 1835, the results showed the actual duty performed by the engine to be 125,095,713 ft. lb. This is the highest performance of any Cornish pumping engine, and the most remarkable fact about it is that it was rather more than six times as great as the work done by the best of Watt's engines.

The author of the paper explains the developments which led to this striking result. Newcomen of Dartmouth, working on the ideas originated by Papin, produced his atmospheric engine—the first practicable and effective steam engine to be brought into use. In 1720 he erected at Wheal Fortune, Ludgvan, the first engine in the county of Cornwall of which there is authentic record, and its marked success proved it to be suitable for the drainage of Cornish mines. Newcomen was followed by several members of the Hornblower family, to one of whom the invention of the compound engine is due, the first engine of this type being made in 1776 at Penryn. From this time until the expiry of Watt's patent or monopoly in 1800 there was a pause, and then began a new era of progress, one of the early results being the invention by Trevithick of the Cornish boiler, the construction of which has remained unaltered to this day. Its introduction must have contributed greatly to the success of the Cornish engines which were being installed in the mines in replacement of the much less economical Watt engines.

Doubts continued to be expressed as to the performance of the Cornish engines and one engineer "proved by theoretical principles that the highest possible duty that such engines could do was only 44,000,000". Wicksteed, principal engineer of the London Waterworks, carried out further trials and it was found that, in practice, the Cornish engineers and engines were exceeding this figure by more than one hundred per cent. In addition to many other interesting details regarding these engines, the paper gives accounts of their adoption in many parts of the country and abroad, notably for the drainage of the Haarlemmer Meer in Holland. One of these engines has recently been placed in a state of preservation by the orders of the Dutch Government. Many items of special interest to engineers are touched upon, such as Trevithick's intuitive perception of the principles of thermodynamics—a subject on which in his time nothing was experimentally known. In his correspondence with Gilbert, his remarks show how far he had anticipated the principles which were definitely established by Carnot many years later. The author concludes with a plea for the support of the Committee for the Preservation of Cornish Engines so that it will be enabled to preserve for all time some of those splendid engines which still remain as monuments to the Cornish engineers.

Psychological Treatment of Crime

THE report to the Home Office on "The Psychological Treatment of Crime", by Dr. Norwood East and W. H. de B. Hubert deals with an investigation carried out over a period of four years by a retired prison medical officer and prison commissioner, and an assistant physician in the department of Psychological Medicine at St. Thomas's Hospital and psychotherapist at Wormwood Scrubs Prison*.

The selection of cases for treatment depended, in the first place, on prison medical officers, who were invited to send in reports about prisoners whom they considered suitable for psychological treatment. Such reports, together with any relevant information available, were first examined by the senior investigator, and prisoners selected by him were transferred to Wormwood Scrubs. Here each case was first studied by the senior medical officer of the prison, and then by him in consultation with the senior investigator before determining the treatment. This procedure, it is stated, was found effective and satisfactory. Nevertheless, it is possible that the inquiry might have taken a different course had a psychologist been consulted earlier. The individuals chosen were mostly those who had failed, or seemed likely to fail, to respond to ordinary discipline and training, but who yet showed willingness to co-operate with the psychotherapist; no general classification, however, determined the selection of any case, since personal factors were always given careful consideration.

No reason is given for the fact that the experiment was restricted to youths and men, though one of the investigators at least found it necessary to extend his research in one instance to a control group of women prisoners. Among their recommendations, the investigators include the appointment of a woman psychotherapist at a prison for women. Of the interesting facts that emerge in the course of the report are several that point to the need for early diagnosis and guidance; among boys sentenced to detention at a Borstal institution but deemed unlikely to benefit from their experience without previous treatment, there were a surprising number who had been sent to an institutional school on account of misbehaviour in early life. Another group of ex-Borstal boys afterwards committed to prison and recommended for treatment included a number suffering from some psychotic disorder. Prisoners subject to more or less severe symptoms of cyclothymia were often found to have committed their crimes at the time of the mood-swing. Hysteria seems to be the commonest, and obsessional behaviour the rarest, affective disorder among the prisoners.

The report as a whole emphasizes that while such treatment is not suitable for all, yet much might be done for a considerable number by psychiatric treatment and control. The most novel change recommended is the establishment of a special penal institution serving four functions: (1) a clinic and hospital for psychotherapeutic treatment, (2) a psychiatric institution for selected cases, (3) a prisoners' colony, and (4) an observation and treatment centre for difficult adolescents.

* Home Office. Report on the Psychological Treatment of Crime. By Dr. W. Norwood East and W. H. de B. Hubert. Pp. iii+166. (London: H.M. Stationery Office, 1939.) 2s. 6d. net.

Science News a Century Ago

Mode of Operation of Poisons

IN a paper entitled "Experimental Researches on the mode of operation of Poisons" read to the Royal Society on June 6, 1839, J. Blake gave an account of experiments undertaken to show with what rapidity the blood is circulated through the body. He summarized his conclusions as follows:

"(1) The time required for a substance to penetrate to capillary vessels may be considered as unappreciable. (2) The interval elapsing between the absorption of a substance by the capillaries, and general diffusion through the body, may not exceed nine seconds. (3) An interval of more than nine seconds always elapses between the introduction of a poison into the capillaries, in veins, and the appearance of its first effects. (4) If a poison be introduced into a part of the vascular system nearer the nervous centres, its effects are produced more rapidly".

The Great Lakes of North America

AN American correspondent of the *Athenæum*, writing from New York on June 7, 1839, referred at some length to the theories of rain put forward by the meteorologist J. P. Espy (1786–1860). He then went on to remark: "The water subject reminds me of an interesting statement respecting our great north-western lakes, which appears in the last Report of the *Michigan State Geologist*—a region, by the way, which has been but two or three years a *State*. Such facts show that practical science, as I have hinted before, like practical literature, is really exciting some attention amongst us. The following is the only authentic tabular view of these waters I have seen; it may be of novelty to some of your readers.

	Mean Length	Mean Breadth	Area Sq. Miles
Superior ..	400	80	32,000
Michigan ..	220	70	22,000
Huron ..	240	80	20,000
Green Bay ..	100	20	2,000
Erie ..	240	40	9,600
Ontario ..	180	35	6,300
St. Clair ..	20	14	360

"The same tabular statement exhibited also the depth and the elevation of each above tide water.

	Mean Depth Ft.	Elevation Ft.
Superior	900	596
Michigan	1,000	578
Huron	1,000	578
St. Clair	20	570
Erie	84	563
Ontario	500	232

"It is computed that the lakes contain about 14,000 cubic miles of water, a quantity more than half of all the fresh water on the earth."

American Convention of Civil Engineers

THE *Mechanics' Magazine* of June 8, 1839, had a note to the effect that the American civil engineers, after various preliminary meetings, resolved to form a society similar in its aims to the Institution of Civil Engineers, in London. The Franklin Institute, Philadelphia, offered its co-operation, the headquarters of the convention were to be at the Franklin Institute and the *Franklin Journal* was to be the recognized organ of the new body. Mr. Benjamin H. Latrobe, of Maryland, was elected president.

Societies and Academies

Dublin

Royal Irish Academy, April 24.

W. H. MCCREA: Matrices of quaternions and the representation of Eddington's E-number. An 'algebra' consists of the body of theorems which can be proved true of a set of 'elements' or 'quantities' obeying stated rules of addition and multiplication. For example, we have the well-known algebras of real numbers, of complex numbers, and of Hamilton's quaternions. It is known that under certain conditions the quantities of one algebra may be represented by 'matrices' composed of the quantities of another algebra. In recent years Sir Arthur Eddington has given a formulation of quantum theory and relativity theory based upon the algebra of what he calls 'E-numbers'. The main object of the present paper is to show how Eddington's algebra may be represented by matrices of quaternions.

Edinburgh

Royal Society of Edinburgh, March 6.

ENID CHARLES: Differential fertility in Scotland. (2). The mining and metal industries were associated with either average or very high gross reproduction rates. Low fertility was associated with (*a*) textile industries, (*b*) commerce and finance, (*c*) personal service. In the predominantly agricultural counties, high rates were found in the north-eastern district and Wigtown, low rates in the typically crofting counties and those with large sheep farms. Some correspondence was found between high fertility and intensity of cultivation. All regions with a high proportion of women gainfully employed exhibited low fertility. In general, high fertility of married women was associated with a high nuptiality rate.

R. S. BARCLAY and W. O. KERMACK: The fertility of Scottish married women, with special reference to the period 1926–1935. An investigation has been made of the applicability to Norway and Scotland of the 'Diagonal law', previously found to hold in respect of the specific legitimate fertility rates of certain European countries. The specific legitimate fertility rates for Scotland, 1931, have been employed to calculate standardized general legitimate fertility rates for various regions of Scotland for the period 1926–1935. The results are summarized in various tables and maps.

H. P. DONALD: Sources of variation in human birth weights. On the basis of birth weights of 3,000 full-term infants, it is concluded that those born in summer are slightly heavier than those born in winter. The effect of sex is greater than that of month of birth, is about the same as that of birth order but accounts for comparatively little of the total variation. Age of mother and time between births had no demonstrable effect. By far the greatest source of variation arose from differences in the family averages, an intra-familial correlation of 0·5 being found. This is of significance in connexion with infant mortality, and mental and physical development.

E. L. INCE: Relations between the elliptic cylinder functions. As the elliptic cylinder functions may be regarded as generalizations of the circular functions, the question arises as to whether there corresponds to the addition theorems for the circular functions

relations between elliptic cylinder functions of various types. By manipulating the nuclei of the integral equations relative to each of the four types of elliptic cylinder function, relations, though of infinite form, between the functions of any one type and those of each of the others, and likewise expressions for the derivatives have been obtained.

ALAN MOZLEY: The freshwater Molluscs of the Tanganyika Territory and Zanzibar Protectorate. A study of the systematics and local and geographical distribution of East African molluscs carried out under the auspices of the London School of Hygiene and Tropical Medicine. Two species, *Physopsis globosa* and *Biomphalaria pfeifferi*, are of considerable importance there as intermediate hosts of schistosomes parasitic in man. Their local distribution and diverse means of destroying these undesirable snails are described, and suggestions are made regarding the application of these data to specific infested localities.

HUGO MERTON: Studies on reproduction in the albino mouse. (2). Maturation of spermatozoa. Active spermatozoa from the vas deferens and cauda epididymis possess a protoplasmic droplet at the posterior end of their middle piece. This is not a remnant of the expelled cellular protoplasm, but is a special substance required for the completion of their maturation process.

F. A. E. CREW and P. C. KOLLER: Cytogenetical analysis of the chromosomes in the pig. The diploid chromosome number in the spermatogonial cells is 38. The largest chromosome is 7·5 μ long, the smallest is 1·5–2 μ. The rest form a graded series between these extremes. The two sex chromosomes are unequal in size; the *Y* being 1/3 of the total length of the *X* chromosome. The position of the centromere in the *X* is subterminal; in the *Y* it is terminal or nearly so. The type and the structure of the sex bivalent suggests that the centromere separates the pairing and differential segments. Chiasma formation is localized in the five larger bivalents, and consequently gene recombination in these bivalents is limited. In one individual a chromosome pair was heterozygous for a small and distal inversion.

Paris

Academy of Sciences (*C.R.*, **208**, 1177–1256, April 17, 1939).

E. BOREL: Certain problems of distribution and the virtual probabilities.

J. DRACH: Application of Darboux's method to equations with explicit characteristics, *x*, *y*.

L. LECORNU: Propagation of spherical waves.

J. HAAG: Cauchy's formula and the problem of Dirichlet.

A. MAIGE: Cellular autotrophy and heterotrophy and evolution of the plastid.

L. DANIEL: Graft of a hybrid cineraria on *Senecio scandens*.

C. CHABAUTY: Demonstration of a theorem of Thue, independent of the theory of diophantine approximations.

J. LE ROUX: Free mobility in geometry.

A.-Y. AMIN: The *F*-points of the surface of Del Pezzo in space of five dimensions.

S. MANDELBROJT: Some new considerations on classes of functions of which the derivatives are bounded.

J. DUFAY and D. SMOUKOVICH: Optical density of the Milky Way in a direction perpendicular to the galactic plane, deduced from star counts.

J. LAGRULA: Measurements of the intensity of gravity in Tunisia.

F. CARBENAY: Weakening of high-frequency transmissions on power transport lines.

A. LALLEMAND: Experimental results obtained by photo-electronic photography.

S. PROCOPIU: Determination of the thickness of the thinnest layer of electrolytic iron at which magnetization discontinuities disappear. Magnetic induction and thickness give a straight line relation, magnetic induction being zero at a thickness of 1·75 μ.

L. BLOCH, E. BLOCH and L. KOUANG-TAO: Vacuum spark spectrum of silver. A great number of new radiations, often very intense, have been observed.

MME. T. GRIVET-MEYER: Secondary effects of cosmic rays in lead.

C. MAGNAN: Concerning the neutrons emitted during the splitting of uranium under the action of neutrons.

L. GIRAUT-ERLER: Theory of differential potentiometric titration.

MME. N. DEMASSIEUX and B. FEDOROFF: Dehydration of potassium cobalt sulphate and of cobalt sulphate. The changes have been followed by Debye and Scherrer diagrams.

G. LEJEUNE: Solubility of ether oxides in solutions of strong acids.

P. CHOVIN: Researches on the Pechmann colouring matters. Mechanism of formation of the mono-acid by hydrolytic scission.

C. COURTOT and J. KROUSTEIN: New syntheses in the dibiphenylene-ethene series.

Z.-C. GLACET and J. WIEMANN: Condensing reductions.

S. GOLDSZTAUB: Arrangement of the atoms in laurionite, PbOHCl.

J. BRICARD: Study of the formation of rime at the summit of the Puy de Dôme.

D. BARBIER and D. CHALONGE: Night temperature of the upper layers of the atmosphere. Comparison of the ozone bands of stellar spectra indicates a very low temperature in the upper atmosphere.

M. and MME. J. FELDMANN: Development of carpospores and the alternation of generations in *Asparagopsis armata* Harvey.

S. SABETAY and L. TRABAUD: Presence of eugenol in the essential oil of jasmin.

G. TRÉGOUBOFF: Plankton larvæ of sponges.

G. JORET and H. MALTERRE: Mechanical constitution of soils and the solubility of phosphoric acid.

P. DE BERREDO-CARNEIRO: Strychnolethaline, curare and curarization.

MME. M. PHISALIX: The white venom of vipers of the Departement du Gers has no vaccinating power.

M. PIÉRY, J. ENSELME, MME. J. ENSELME and C. PESCHERA: Experimental study of the biological influence of a prolonged stay at a height. Blood modifications. Geese and rabbit were sent to the scientific station at the Jungfraujoch (3,457 m.) for six months. A lowering of blood carbon dioxide and of the oxygen saturation of the arterial blood, already known, due to decreased partial pressures of these gases, and also an increase in the number of red corpuscles and in the oxygen capacity of the blood, were observed.

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

ASSISTANT LECTURER IN ECONOMICS in the University of Manchester—The Registrar (June 10).

Academic Appointment in the DEPARTMENT OF PHYSICS in University College, Hull—The Registrar (June 10).

ASSISTANT III for the EXTERNAL BALLISTIC DEPARTMENT of the Ordnance Board, Woolwich, S.E.18—The Secretary (June 10).

ASSISTANT COUNTY EDUCATION OFFICER under the Southampton Education Committee—County Education Officer, The Castle, Winchester (June 12).

FELLOW AND TUTOR IN CHEMISTRY in Jesus College, Oxford—The Principal (June 13).

DEMONSTRATOR IN THE DEPARTMENT OF ZOOLOGY in Bedford College for Women, Regent's Park, N.W.1—The Secretary (June 15).

UNIVERSITY CHAIR OF PATHOLOGY at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, Senate House, W.C.1 (June 15).

ASSISTANT at the London Museum, St. James's, S.W.1—The Keeper (June 15).

JUNIOR ASSISTANT PHYSICIST at the Radium Beam Therapy Research, 1 Riding House Street, W.1—The Honorary Secretary (June 24).

ASSISTANT PHYSICIST at the Radium Beam Therapy Research, 1 Riding House Street, W.1—The Honorary Secretary (June 24).

RESEARCH OFFICERS (2), Grade III, in the AGRICULTURAL ECONOMICS RESEARCH INSTITUTE, University, Oxford—Secretary of the Committee for Rural Economy, School of Rural Economy, Parks Road, Oxford (July 1).

LECTURER IN PATHOLOGY AND DIRECTOR OF THE PATHOLOGICAL UNIT at Prince Henry Hospital, Sydney—The Secretary, Universities Bureau of the British Empire, Gower Street, W.C.1 (August 31).

TECHNICAL OFFICERS at the Air Ministry Headquarters—The Under-Secretary of State, Air Ministry, Berkeley Square House, W.1 (quoting B.197).

A PATHOLOGIST in King Edward VII Hospital, Windsor—The Secretary.

Reports and other Publications

(not included in the monthly Books Supplement)

Great Britain and Ireland

International Tin Research and Development Council. Publication No. 92: Electro-Tinning. By S. Baier. Pp. 16. (Greenford: International Tin Research and Development Council.) Free. [35

National Institute of Agricultural Botany. Nineteenth Report and Accounts, 1937–38. Pp. 26. (Cambridge: National Institute of Agricultural Botany.) [85

Association of Short-Circuit Testing Authorities. Publication No. 1: General Information on the Short-Circuit Testing and Certification of Electrical Apparatus. Pp. 28. (London: Association of Short-Circuit Testing Authorities.) [85

Freshwater Biological Association of the British Empire. Scientific Publication No. 1: A Key to the British Species of *Corixidæ* (Hemiptera-Heteroptera), with Notes on their Distribution. By T. T. Macan. Pp. 28. (Ambleside: Freshwater Biological Association of the British Empire.) 1*s.* 6*d.* [85

International Tin Research and Development Council. Publication 93: Notes on Soldering of Lead Pipes and Sheet Metals. By W. R. Lewis. Pp. 24. (Greenford: International Tin Research and Development Council.) Free. [85

World Power Conference. Annual Report, 1938. Pp. 17. (London: World Power Conference.) [95

Board of Education: Science Museum. Report of the Advisory Council for the Year 1938. Pp. 48+14 plates. (London: H.M. Stationery Office.) 1*s.* 6*d.* net. [95

Scientific Proceedings of the Royal Dublin Society. Vol. 22 (N.S.), No. 9: The Ovule, Gametophytes and Proembryo in *Saxegothæa*. By W. J. Looby and J. Doyle. Pp. 95–117+plates 2–3. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 3*s.* [95

Department of Scientific and Industrial Research. Report of the Water Pollution Research Board for the Year ended 30th June 1938; with Report of the Director of Water Pollution Research. Pp. iv+57. (London: H.M. Stationery Office.) 1*s.* net. [105

Leeds University: Department of Pathology and Bacteriology. Report for the Years 1937 and 1938, by Prof. Matthew J. Stewart and Prof. J. W. McLeod, with Abstract Report on Experimental Pathology and Cancer Research, by Prof. R. D. Passey. Pp. 20. (Leeds: The University.) [125

Statistical Year Book, 1939, of the International Tin Research and Development Council. Pp. 206. (Greenford and The Hague: International Tin Research and Development Council.) 8*s.* [155

University of Liverpool: Social Science Department, Statistics Division. Population Problems of New Estates, with Special Reference to Norris Green. Pp. 52. (Liverpool: University Press of Liverpool.) 1*s.* net. [175

Agricultural Research Council. A.R.C. Report Series, No. 4: Tuberculin Tests in Cattle; Observations on the Intradermal Tuberculin Test in Cattle, with Special Reference to the use of Synthetic Medium Tuberculin. By J. R. Buxton and R. E. Glover. Pp. v+94. (London: H.M. Stationery Office.) 1*s.* 6*d.* net. [175

Other Countries

Government of India: Department of Communications. Functions and Organisation of the India Meteorological Department, 1939. Pp. 23. (New Delhi: Government of India Press.) [15

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 28: Bibliography of Soil Erosion. Part 1: Indian Section. Compiled by Dr. R. Maclagan Gorrie. Pp. iv+55. (Delhi: Manager of Publications.) 1.12 rupees; 2*s.* 6*d.* [15

Publications of the Isostatic Institute of the International Association of Geodesy. No. 5: Catalogue of the Isostatically Reduced Gravity Stations. By Prof. Dr. W. Heiskanen. Pp. 140. (Helsinki: International Association of Geodesy.) [15

Palæontologia Indica. New Series, Vol. 25, Memoir No. 1: The Cephalopoda of the Neocomian Belemnite Beds of the Salt Range. By Dr. L. F. Spath. Pp. vi+154+25 plates. (Calcutta: Geological Survey of India.) 17.12 rupees; 27*s.* 6*d.* [25

Ministry of Commerce and Industry, Egypt: Hydrobiology and Fisheries. Notes and Memoirs No. 21: The Fishery Grounds near Alexandria. 13: Echinoderma. By Th. Mortensen and Ad. Steuer. Pp. 37. Notes and Memoirs No. 25: The Fishery Grounds near Alexandria. 14: Turbellaria. By Otto Steinböck. Pp. 15. Notes and Memoirs No. 26: The Fishery Grounds near Alexandria. 15: Cumacea, Stomatopoda, Leptostraca. By Adolf Steuer. Pp. 16. Notes and Memoirs No. 28: The Fishery Grounds near Alexandria. Ascidiacea. Par Dr. Hervé Harant. Pp. 7+5 plates. Notes and Memoirs No. 31: Plankton of the Egyptian Waters. Two Cladocera from the Plankton. By Dr. F. M. Ghazzawi. Pp. 2+5 plates. Rapport sur les pêcheries d'Egypte en 1935. Par Hussein Faouzi. Pp. vi+133. (Cairo: Government Press.) [35

Bulletin of the American Museum of Natural History. Vol. 76, Art. 2: Carnivora of the Tung Gur Formation of Mongolia. By Edwin H. Colbert. Pp. 47–81. (New York: American Museum of Natural History.) [35

League of Nations: Information Section. The League from Year to Year (1938). Pp. 214. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 1*s.* [35

Union of South Africa: Department of Agriculture and Forestry. Science Bulletin 180 (Chemical Series 155): The Natural Decomposition of Bat Manure. By J. Vorster Nel. Pp. 22. (Pretoria: Government Printer.) 3*d.* [35

Proceedings of the U.S. National Museum. Vol. 86, No. 3069: A New Sea Star of the Genus *Porcaniopsis* from Japan. By Walter K. Fisher. Pp. 469–472+plates 55–56. (Washington, D.C.: Government Printing Office.) [35

Statistical Theory of Estimation. By Prof. R. A. Fisher. (Calcutta University Readership Lectures.) Pp. v+45. (Calcutta: University of Calcutta.) [35

Report on the Danish Oceanographical Expeditions 1908–1910 to the Mediterranean and Adjacent Seas, No. 11. Vol. 2 (Biology), H. 2: *Siphonophoræ*, by Henry B. Bigelow and Mary Sears; D. 6: *Euphausiacea*, by Johan T. Ruud; E. 1: Pelagic Polychætes of the Families *Aphroditidæ*, *Phyllodocidæ*, *Typhloscolecidæ* and *Alciopidæ*, by Elise Wesenberg-Lund. Pp. 144+96+46. (Copenhagen: Andr. Fred. Høst and Son.) 30*s.* [35

Indian Forests Records (New Series.) Entomology, Vol. 5, No. 1: On the Biology of the Cerambycidæ (Coleopt.). By C. F. C. Beeson and B. M. Bhatia. Pp. v+235+8 plates. (Delhi: Manager of Publications.) 6.12 rupees; 10*s.* 6*d.* [35

Koninklijke Vereeniging "Koloniaal Instituut", Amsterdam. Acta en twintigste Jaarverslag 1938. Pp. 135. (Amsterdam: Koloniaal Instituut.) [35

Journal of the Indian Institute of Science. Vol. 22A, Part 5: Influence of Certain Anions on the Accuracy of the Titrametric Method of Estimating Phosphoric Acid in Solution. By A. Sreenivasan. Pp. 79–92. 1.2 rupees. Vol. 22A, Part 6: Supersonic Velocity in Gases and Vapours. Part 8: Supersonic Velocity in Air, Steam, Carbon Dioxide and Carbon Disulphide. By S. K. Kulkarni Jatkar. Pp. 93–110. 1.2 rupees. Vol. 22A, Part 7: Reactions of Chromates at High Temperatures. Part 8: The 25% Stage in the Decomposition of the Chromates of Calcium, Strontium and Barium. By D. S. Datar, V. T. Athavale and S. K. K. Jatkar. Pp. 111–118. 12 annas. (Bangalore: Indian Institute of Science.) [35

U.S. Department of the Interior: Office of Education. Bulletin, 1938, No. 16: Accredited Higher Institutions, 1938. By Ella B. Ratcliffe. Pp. v+212. (Washington, D.C.: Government Printing Office.) 20 cents. [35

Smithsonian Miscellaneous Collections. Vol. 98, No. 3: The Embryology of Fleas. By Edward L. Kessel. (Publication 3627.) Pp. 78+12 plates. (Washington, D.C.: Smithsonian Institution.) [115

Brooklyn Botanic Garden Record. Vol. 28, No. 2: Containing the Twenty-eighth Annual Report of the Brooklyn Botanic Garden, 1938. Pp. 159. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) [125

Tanganyika Territory: Department of Lands and Mines, Geological Division. Short Paper No. 22: Outline of the Geology of the Uruwira Mineral Field. By G. M. Stockley. Pp. 22. (Dar es Salaam: Government Printer.) 2*s.* 6*d.* [155

Memoirs of the Geological Survey of India. Vol. 73: The Bihar-Nepal Earthquake of 1934. By Officers of the Geological Survey of India; Seismological Study by Dr. S. C. Roy. Pp. ix+391+xvii+36 plates. (Calcutta: Geological Survey of India.) 10.14 rupees; 17*s.* [155

Publications of the Observatory of the University of Michigan. Vol. 7, No. 6: Spectrophotometric Determinations of Stellar Temperatures, 2: The Absolute Color Temperatures of Seven Standard Stars. By Robley C. Williams. Pp. 147–158. Vol. 7, No. 7: Spectrophotometric Determinations of Stellar Temperatures, 3: A Comparison of Relative Color Temperatures. By Robley C. Williams. Pp. 159–170. (Ann Arbor: University of Michigan.) [165